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DEFINITION, DESCRIPTION, AND INTERFACES OF THE FAA'S DEVELOPMENTAL PROGRAMS

VOLUME II: ATC FACILITIES AND INTERFACES

SEPTEMBER 1978

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Office of Systems Engineering Management
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16. Abstract

This report describes the evolution of the air traffic control system facilities in the pre-1990 time period as major system improvements currently being developed by the FAA are implemented. The description was prepared to assist FAA managers with the technical planning for the future air traffic control system. The description covers eight major domestic ATC facility classifications: En Route TRACON, Tower, ATC System Command Center, Flight Service Stations, Surveillance, Navigation, and Communications. The report provides a summary description of each improvement currently being planned, describes the information flow between ATC facilities to support the improvement, and provides tentative implementation dates for each improvement. An overview of this material as well as an overall ATC system configuration description and a single thread Instrument Flight Rule operations flight description illustrating the effect of planned improvements is given in Volume I of this series of documents. Where open system configuration questions were encountered, an assumption about the final course of action was made and duly noted. These assumptions generally identify major questions involving two or more programs that the FAA will be addressing prior to reaching implementation decisions. Some smaller design modifications that might result in a smoother functioning system are also identified.

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PREFACE

The system described in this document was prepared to make explicit the system interfaces implied by the current FAA program of planned ATC system improvements and to identify those interfaces that merit FAA planning attention. The descriptions in this document were based on information available to the authors as of September 1978. Specific features of the system described herein may be modified as the development cycle provides more information about the technical feasibility and operational desirability of proposed improvements. Also, some improvements may be deferred or dropped from the program and others will be expedited or added as the perceived operational needs of the ATC system, internal FAA priorities, and availability of funds change over time. Thus, while this document may be viewed as an aid to the technical planning for system implementation, it does not necessarily reflect the ATC system that will actually be in place by a given time period, nor does it imply that the FAA is committed to the implementation of all or any of the features described in this report.

ACKNOWLEDGEMENTS

This document, "Definition, Description, and Interfaces of the FAA's Developmental Programs," is based on the assimilation of information from many sources. Many people contributed information as to the description and status of various programs aimed at providing incremental improvements to the ATC System. Various levels of coordination were conducted with FAA personnel concerned with individual program elements that are expected to be a part of the ATC System at some future point in time. Drafts of this document were submitted to the Systems Research and Development Service (SRDS), Airway Facilities Service (AAF), Air Traffic Service (AAT), Flight Standards Service (AFS), National Aviation Facilities Experimental Center (NAFEC), Office of Aviation System Plans (ASP), and Office of Aviation Policy (AVP). The material in this document reflects this coordination cycle. The authors, of course, assume full responsibility for any remaining errors.

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1. INTRODUCTION

This document summarizes work performed by MITRE Metrek for the FAA's Office of Systems Engineering Management Technical Programs Division (AEM-200). The objective of the task was to:

- -- describe the CONUS ATC system after current major E&D features are developed and integrated into the operational system,
- -- identify and describe the interfaces between systems that will have to be provided, and
- -- identify and describe design and time phasing concerns that need to be addressed by the FAA.

1.1 Scope

The scope of the project was limited to systems within CONUS operated by the FAA that are directly related to the provision of ATC services. In addition, the system improvements described were limited to those items in the current E&D program that were targeted for implementation and that had been defined to a level of detail that their interfaces with other systems could be examined. Such efforts as the Automated Terminal System (ATS) and Automated En Route Air Traffic Control (AERA), for example, were considered to be at a preliminary stage of development and were not considered in detail, but their potential impact was briefly noted where applicable. Evolutionary system improvements planned for widespread implementation by the Air Traffic Service (AAT) and the Airway Facilities Service (AAF) were also included, but limited application system patches were excluded.

This description considers the transition of the current ATC

system to the time period when most major element of the current E&D program will be implemented. Although it was difficult, and not essential to this document, to select specific implementation dates, the period covered roughly extends until the 1990 time frame.

The system description is limited to normal mode operations intended to provide ATC services to users. As a result, certain functions are not considered. These functions include failure mode operations, administrative features, and system maintenance and record keeping functions that are purely internal to the FAA. Some remote maintenance and monitoring improvements that are an integral part of future operational systems are included, however.

Finally, the system description was intended to serve as an internal planning aid based on current management decisions as to the proper courses of system design action. The document does not try to justify these decisions or examine system-wide alternatives to these planned courses of action. Cost, benefit, and system requirements relationships were not examined. However, the need for additional studies of this sort to select among known active alternatives or to explore system additions where no design decisions have been made, were noted as a part of the identification of interface planning concerns.

1.2 Approach

To meet the stated objective, a strawman future ATC system description was prepared to illustrate the expected ATC system configuration if current FAA system improvement plans were realized. This description is facility-oriented and focuses on the technical operation of the hardware, software, and sensors used by ATC personnel to deliver new or improved services.

This description shows how the particular ATC facilities are connected to other parts of the system and how these facilities and their associated connections are expected to change over time. Features that do not change are either deemphasized or set aside.

1.2.1 ATC Facilities

For this study the ATC system was subdivided into facilities as noted in Table 1-1. The grouping of facilities falls along rather natural lines with some arbitrary assignments being made for some services. For example, the flight plan data distribution system for TRACON and towers was primarily treated in the TRACON Facility chapter as the TRACON is generally a user of the current Flight Data Entry and Printout (FDEP) and is projected to be a user of the future Terminal Information Processing System (TIPS) equipment, although tower facilities may also use this equipment. Also, ATC services, such as separation assurance that use features that reside in a number of facilities were discussed in several chapters of the document. For example, the Beacon-based Collision Avoidance System (BCAS) and Automated Traffic Advisory and Resolution Service (ATARS) were described in both the En Route and TRACON chapters.

1.2.2 Time Periods

Facility descriptions were prepared for three time periods: Current, Near Term, and Far Term. The "current system" was defined as consisting of those systems substantially in place by the end of calendar year 1978, including those system improvements that were funded for implementation in fiscal year 1977 or earlier years but that were not completely operational by the end of calendar year of 1978. The current system is

TABLE 1-1
ATC SYSTEM FACILITIES

Chapter	Facilities	Primary Operational Services Provided
2. En Route Facilities	ARTCC	En route ATC control and flight data handling of IFR flights
3. TRACON Facilities	ARTS IIIA, ARTS III, ARTS II, TPX-42	Terminal ATC control of IFR and VFR arrivals, departures, and overflights
4. Tower Facilities	Tower Cabs, electronic ground traffic surveillance, wind shear and wake vortex monitoring	Airport ATC control of IFR and VFR landings, takeoffs, and ground traffic
5. System Command Center	ATC System Command Center	Central IFR traffic flow management and central ATC emergency command center
6. Flight Service Facilities	FSS, Automated FSS, Flight Service Data Processing System, Aviation Weather Processor	Preflight and weather briefing, VFR flight plan filing and monitoring, IFR flight plan filing, emergency location and search coordination services, weather and flight condition data acquisition and dissemination.
7. Surveillance Facilities	Search Radar, ATCRBS, DABS, Joint use weather radar	Electronic surveillance of airborne aircraft via primary and secondary radar and radar surveillance of weather
8. Navigation Facilities	VOR/DME, TACAN, RNAV, ILS, MLS, NDB	Electronic guidance for en route, terminal and landing operations
9. Communication Facilities	FAA voice and data input, output, switching, signaling, transmission, receiving and distribution facilities	Voice and data communication linking the facilities cited above -- ground/ground and ground/air/ground

the reference point for examining system changes and is presented only to a level of detail that is necessary to highlight system changes. This description is incomplete in most cases and is not intended as a tutorial on current system operations.

The "Near Term system" was defined as the Current system modified to include those system improvements that could, according to current system plans, be substantially implemented by the end of calendar year 1982. Many of the anticipated Near Term improvements have already been approved for implementation and some have active procurement contracts. System improvements that have been approved for implementation have been noted in the documentation.

The "Far Term system" was defined as the Current system modified to include implementation of all system improvements in the current FAA E&D and operational service programs excluding non-CONUS, non-ATC, or long range research system improvements. This post-1982 Far Term system is somewhat tentative because of the additions, deletions, and modifications that naturally occur in a dynamic research and development program.

1.2.3 Document Structure

The work undertaken in this study is reported in several documents. Volume II describes the system evolution and interfaces for specific facilities. Volume I merges the specific facility information in Volume II into a description of the overall system configuration. A series of short papers that focuses on the system configuration and design questions that FAA management will be considering as the future ATC system evolves was also prepared during the course of the study. These papers were prepared as a result of the major assumptions that were made in this document

as to how specific E&D products would be incorporated into the ATC System.

Each facility description chapter in Volume II follows roughly the same outline. The intent was to highlight system interface requirements between particular facilities and between particular improvements within a given facility for each of the three time periods. For example, the En Route Facilities Chapter highlights interfaces between ARTCC automation and en route surveillance sites as well as interfaces internal to the ARTCC automation, such as between the Electronic Tabular Display Subsystem (ETABS) and the Direct Access Radar Channel (DARC).

Each facility description in Volume II consists of:

- an improvements summary.
- a connectivity diagram.
- an information flow diagram.
- a tentative implementation schedule.
- an interface planning summary.

The improvements summary gives a brief description of the nature of each improvement and the expected advantages that will accrue to the system by its implementation.

The connectivity diagram specifies the type of data directly relating to the delivery of ATC services and the general transmission media (directly wired, digital data channel, teletypewriter channel, video channel, or facsimile transmission) associated with interfacility communication links. Within the facility chapter, the designation of communication media is at the general level; the specific FAA leased or operated switching and transmission capabilities used for these links is given in the Communication Chapter.

The information flow diagram presents the specific inputs, outputs, and internal functions that must be accomplished for each ATC system improvement.

For each of the preceding sections, the emphasis is on the system interface changes that will occur in the two time periods, with minimum attention given to explaining the operation of the existing system except as a point of reference.

The tentative implementation schedule is based on projected technical data package (TDP) handoff dates for Far Term improvements and on budgetary information for most Near Term improvements. The implementation dates shown follow TDP handoff by one to three years, depending on the estimated complexity of the procurement. The changeable and rather optimistic nature of these estimates, particularly for Far Term items, limits their usefulness in examining fine grained precedence relationships.

The interface planning summary cites two types of system concerns: "interface/evolution open items" and "interface adjustments." The topics included in the "interface/evolution open item" category require examination and decision at or above the FAA Division Chief level. In general, they involve major assumptions that were made in this document as to how the ATC system will incorporate results of the FAA E&D program. The "interface adjustments" can generally be resolved below the FAA Division Chief level and generally involve minor changes in system plans. Many of the adjustments and open items discussed in this section have been under review by FAA managers as this document was published. The circumstances that prompted citing open items were generally of a transitory nature and are likely to be modified substantially in a short time.

2. EN ROUTE FACILITIES

As described in this chapter, an En Route Facility consists generally of those portions of the en route air traffic control system that are contained in the ARTCC (Air Route Traffic Control Center) building. The facility consists of en route ATC (Air Traffic Control) system equipment, en route ATC system software, and the personnel associated with this equipment and software. Other equipment and functions are physically located at en route facilities but are not discussed in this chapter. For example, NADIN (National Airspace Data Interchange Network) concentrators, NADIN switches, and voice radio equipment are, or will be, located at en route facilities. These are described in Chapter 9. Similarly, Flight Service Data Processing Systems (FSDPS) are to be located at ARTCCs but are described in Chapter 6 rather than in this chapter.

The emphasis in this chapter is on those en route functions directly related to the providing of ATC services. Administrative functions, maintenance, logistics, etc., are not included. The communications within the building and between the building and other elements of the system are generally not described; however, the external interfaces and the types of information sent across these interfaces are indicated.

The remainder of this chapter consists of the following sections:

- En Route Facilities Improvements Summary (2.1). This section lists important functional areas and the improvements planned for these areas. For each function, there is a separate brief description of the method by which the function is currently performed, the planned improvement(s) and the manner in which the improvement(s) would enhance the performance of the function.

(Further, more detailed information in regard to each improvement is contained in Section 2.3).

- En Route Facilities System Connectivity (2.2). This section contains three connectivity diagrams -- one for each of the three system phases: Current, Near Term, and Far Term. The changes in connectivity between phases are briefly described.

- En Route Facilities Information Flow (2.3). This section contains three Information Flow Diagrams -- one for each of the three system phases (see above). The diagrams show the facilities that provide inputs to an ARTCC, the principal types of inputs provided by each of these facilities, ARTCC functions, the facilities that are provided with outputs from an ARTCC, and the principal types of outputs provided to those facilities by the ARTCC. The information flow for each function that was identified in Section 2.1 is then described in a separate series of paragraphs.

- En Route Facilities Tentative Implementation Schedule (2.4). This section contains a figure that shows the tentative implementation schedule for the principal improvements affecting the En Route Facilities.

- En Route Facilities Interface Planning Summary (2.5). This section summarizes the major assumptions that were made in regard to: what improvements would be implemented, when they would be implemented, how they would function in an En Route Facility, and how they would interact with other facilities.

2.1 En Route Facilities Improvements Summary

Table 2-1 summarizes the En Route Facilities Improvements that, according to current plans, are expected to be implemented in the Near Term and Far Term. Each of these functions/features and the improvements in them are briefly described in the following paragraphs. More detailed information is contained in Section 2.3. In addition to the improvements that are listed in Table 2-1, there are other potential improvements that are less likely to be implemented according to current plans. Such additional potential improvements are briefly described at the end of this section.

Monitoring Nearness to Ground

Currently, controllers detect aircraft that are too close to the ground by comparing displayed aircraft altitudes to the minimum safe altitudes of the areas in which the aircraft are operating.

In the Near Term, this function is expected to be automated through the implementation of EMSAW (En Route Minimum Safe Altitude Warning System). EMSAW would use computer software to compare aircraft altitudes to the minimum safe altitudes of the areas in which the aircraft are flying and warn controllers of aircraft that are at dangerously low altitudes. No Far Term changes are included in the current plans. See 2.3.1 for further information.

Management of Traffic Flow Near Terminals

Currently, metering position personnel or controllers manually calculate estimated times of arrival and manually determine means of improving the spacing and sequencing of aircraft to the terminal feeder fixes in a fuel-conservative manner. In the Near

TABLE 2-1
EN ROUTE FACILITIES IMPROVEMENTS SUMMARY

Functions/Features	Current System (1978)	Near Term Improvements (1979-82)	Far Term Improvements (Post-1982)
1. Monitoring Nearness to Ground	Manual	En Route MSAW	NC
2. Management of Traffic Flow Near Terminals	Manual	En Route Metering	NC
3. Real-Time Management of Traffic Load	Manual	NC	NC
4. Planning of Conflict-Free Paths	Manual	Flight Plan Conflict Probe	NC
5. Determination of Immediate Potential Aircraft Conflicts	Conflict Alert	Conflict Alert Enhancements	• ATARS
6. Resolution of Immediate Potential Aircraft Conflicts	Manual	Manual	• ATARS • Conflict Resolution Advisory
7. Entry and Display of Controllers' Flight Data	Computer Entry & Readout Devices and Flight Strip Printers	NC	ETABS
8. Backup Surveillance Display Capability	Broadband	DARC* Replaces Broadband	NC
9. Communication with Aircraft	Voice via Radio	NC	Data Link (DABS) Available
10. Input, Output, and Display Processing	CCC and Data Entry and Display Subsystems	• Weather Display Enhancements • Backup through DARC	• Additional Weather Display Enhancements
11. Radar Data Processing and Automatic Tracking	CCC	• CCC with DARC as Backup • Tracking Enhancements	DABS Added
12. Computer Systems' Capacity & Reliability	9020A, 9020D, 9020E CDC	Computing Element Processing Offloaded onto IOCEs	NC
13. Flight Data Processing	Automated (CCC)	NC	NC
14. Aviation Weather Collection & Dissemination	NWS Remote Weather Services for the ARTCC	Center Weather Service Unit (CWSU)	CWSU Enhancements
15. System Maintenance and Monitoring	• SMMC • Manual Monitoring and Certification	Remote Maintenance Monitor System (RMMS) for RCAGs	RMMS for Navigation Aids & En Route Surveillance Sites

* = Approved by the FAA for Implementation
NC = No Change Included in Current Plans
NA = Not Applicable

Term, it is expected that an automated En Route Metering function will be implemented. En Route Metering would de-randomize the arrival of aircraft at the terminal feeder fixes so as to minimize congestion, delays, fuel consumption, and noise in and around terminal areas. It would calculate estimated and desired arrival times and would provide advisories to improve the spacing and sequencing.

In the Far Term, En Route Metering would be integrated with Flight Plan Conflict Probe so as to provide conflict-free metering instructions. An automated interface would be provided between En Route Metering and Terminal Metering and Spacing (M&S) so as to allow the exchange of metering data including such real-time information as runway acceptance rates, runway slot usage, or flight data for specific terminal flights. En Route Metering would also incorporate analytical capabilities for the selection of the most fuel-conservative manner of absorbing delays involving one or more aircraft. Profile descents, speed changes, path stretching, and holding patterns would be among the possibilities considered by the function. See 2.3.2 for further information.

Management of Traffic Load

Currently, local flow controllers manage traffic load with virtually no automation aid. Although no direct improvements are planned in either the Near Term or Far Term, indirect improvements would be available through En Route Metering and Flight Plan Conflict Probe. Thus, En Route Metering would simplify local flow controllers' work because of its organization and smoothing of traffic flow to terminal areas. Through the use of Flight Plan Conflict Probe, local flow controllers would be able to detect future overloading of sectors and would

be able to test tentative rerouting of aircraft. See 2.3.11 for further information.

<u>Planning of Conflict-Free Paths</u>

Currently, controllers attempt to plan conflict-free paths through a sector or sectors by manually examining the Calculated Times of Arrival at selected fixes or sector boundaries for the various aircraft that will be in a sector or sectors. It is expected that Flight Plan Conflict Probe will be implemented in the Near Term. It would provide controllers with warnings many minutes in advance of potential violation of separation standards by aircraft and would provide automated means by which controllers could test tentative methods of resolving these future potential conflicts.

In the Far Term, Flight Plan Conflict Probe would be integrated with En Route Metering so that En Route Metering would be able to provide conflict-free metering instructions. See 2.3.3 for further information.

<u>Determination of Immediate Potential Aircraft Conflicts</u>

Currently, through Conflict Alert, controllers are provided with warnings of immediate potential conflicts between Mode C equipped IFR aircraft. When Conflict Alert coverage is in operation down to the floor of surveillance coverage, an excessive number of false alerts may occur -- particularly at low altitudes near terminals. Improvements in Conflict Alert are expected to provide: (1) automatic detection of immediate potential conflicts between a normally tracked aircraft and a Mode C equipped VFR intruder aircraft, (2) fewer false alerts with full altitude coverage and (3) conflict protection for aircraft in holds. These additions and improvements are expected to be

implemented in the Near Term. Related improvements (ATARS and BCAS) are planned for the Far Term. See 2.3.4 for further information.

Resolution of Immediate Potential Aircraft Conflicts

Currently, controllers determine their own solutions to conflict situations. No Near Term changes are included in the current plans. It is expected that the Conflict Resolution Advisory function will be available in the Far Term. It would aid controllers in resolving many of the aircraft conflicts predicted by the Conflict Alert function. The Conflict Resolution Advisory function would provide resolution advisory services for those potential conflicts that have reached an advanced state according to adjustable criteria. See 2.3.5 for further information.

Entry and Display of Controllers' Flight Data

In the present en route system, controllers must handle flight progress strips and must use somewhat difficult means of entering messages into the computer. No improvements in this area are currently planned for the Near Term. ETABS (Electronic Tabular Display Subsystem) is expected to be implemented in the Far Term. It would eliminate flight progress strips, would provide controllers with easier methods of entry and control of flight data, and would provide more usable and more timely information (flight data and other). It would also provide support to sector operations when the CCC (Central Computer Complex) is not operational. See 2.3.6 for further information.

Backup Surveillance Display Capability

Currently, broadband surveillance information is available for backup display use. The broadband capability does not provide displayed data blocks, association of aircraft identification

with beacon codes, etc. DARC (Direct Access Radar Channel) will be implemented in the Near Term. It is a digital backup surveillance data processing capability that will be used when the normal radar display capability is not available. It will provide aircraft targets, data blocks, weather data, and map data on radar controller PVDs (Plan View Display).

Various improvements in DARC are under consideration; however, current plans do not provide for specific improvements in the Far Term. See 2.3.7 and "Additional Potential Improvements" for further information.

Communication with Aircraft

Currently, controllers send and receive much information through voice radio connections with aircraft. In many cases, the available radio channels are heavily used and have little spare capacity.

No Near Term changes are included in the current plans. In the Far Term, Data Link is expected to be implemented and available for use. It would be available to provide rapid non-voice communication between the ARTCC and aircraft. Many routine and high priority messages could be transmitted via Data Link. Work is underway in this area, but as yet, final determination of the use of Data Link for communication between ARTCCs and aircraft has not been made. See 2.3.8 for further information.

Input, Output, and Display Processing

In the current system, Input, Output, and Display Processing are performed by the CCC and Data Entry and Display Subsystem within the ARTCC. (The Data Entry and Display Subsystem

consists of a Computer Display Channel (CDC) or Display Channel Complex (9020E) and other input/output related equipment.)

Improvements in this area would provide improved backup capabilities and better displays of turbulent weather conditions. In the Near Term, a backup capability for ARTCC sector control positions would be provided through the implementation of DARC. In the Far Term, further backup capability for ARTCC sector control positions would be available through the implementation of ETABS. Also in the Far Term, ARTCCs would be indirectly aided as a result of the implementation of TIPS at TRACONs (Terminal Radar Approach Control, IFR Room) and TRACABs (Terminal Radar Approach Control, Tower Cab). The automation equipment at TRACONs and TRACABs would no longer be dependent upon the automation equipment at ARTCCs on a minute-by-minute basis. Instead, ARTCCs would deliver flight plans as much as two hours in advance of flight arrivals or departures. Furthermore, ARTCCs would no longer have to prepare flight progress strips for TRACONs/TRACABs.

In the Near Term, improved Common Digitizers (CD-2) are expected to be available at en route surveillance sites, and digitized three-dimensional weather data would be available from NWS Weather Radars. Both would provide improved weather data for display on PVDs. In the Far Term, further improvements in the display of en route weather are expected through the use of digitized turbulent weather data that is planned to be newly available from Joint Use Weather Radar Sites and/or ARSR Weather Channels. See 2.3.9 for further information.

Radar Data Processing and Automatic Tracking

Improvements in this area would provide a backup capability for the CCC and would provide enhanced Automatic Tracking.

In the Near Term, DARC will be implemented and enhancements to Automatic Tracking are expected to be implemented. DARC will provide substantial information to controllers when the CCC is not available. The improvements to tracking would include enhancements to the altitude tracker and improved reasonableness testing. In the Far Term, DABS is expected to be implemented and would provide improved surveillance data for use by the CCC. See 2.3.10 for further information.

Computer Systems' Capacity and Reliability

The possible replacement or augmentation of en route computer equipment and software is being considered because of the increased needs that are anticipated in regard to computer capacity, reliability, and maintainability. Increases in traffic load and the incorporation of new functions/features will require increased computer capacity. Reliability needs to be increased because it is expected that fewer ATC people per controlled aircraft will be available for manual backup in case of automation failures. Because of aging equipment and possible difficulties in obtaining replacement parts, maintenance may become increasingly difficult. In the Near Term it is expected that some additional Computing Element capacity will be made available through the transfer of a portion of Computing Element load to the under-loaded IOCEs (Input Output Control Elements) in each ARTCC. There are no definite plans for improvement in the Far Term, but various investigations and studies are now underway. See 2.3.12 for further information.

Flight Data Processing

Currently, Flight Data Processing is performed automatically in the CCC. This function collects and processes Flight Plans and related data so as to provide information to controllers and to other processing functions (e.g., Flight Plan Aided Tracking, Conflict Alert). No changes in the automated Flight Data Processing function are currently planned for the Near Term or Far Term. See 2.3.13 for further information.

Aviation Weather Collection and Dissemination

Currently, aviation weather collection and dissemination is not an integrated function within an ARTCC. In the Near Term, Center Weather Service Units (CWSU) will be located in all ARTCCs to provide a consolidation of ARTCC weather services. The CWSUs will be the major focal points for real-time collection, monitoring, interpretation, and dissemination of hazardous weather information. In the Far Term, CWSUs will be enhanced through their inclusion within NWS AFOS (Automation of Field Operations and Services). See 2.3.14 for further information.

System Maintenance and Monitoring

Currently, much of the monitoring of system performance, monitoring of equipment status, routine maintenance, and equipment certification is performed by maintenance personnel through hands-on examination of the equipment and software. Within an ARTCC area, most of the equipment is within the ARTCC building, but some is at remote sites. The System Maintenance Monitoring Console (SMMC) in the ARTCC provides a centralized monitoring and control position for the ARTCC's Systems Engineers. For the equipment within the ARTCC building, extensive status information is automatically sent

to the SMMC on a regular schedule. For remotely located equipment, much less information is automatically made available to the SMMC, and therefore, periodic visits of maintenance personnel to the remote sites are required in order to perform most maintenance and certification functions. (For en route surveillance sites, status messages are periodically sent to the SMMC. For Navigation Aids and RCAGs (Remote Communications Air-Ground), information must be entered manually at the SMMC after it is received by voice telephone).

The FAA is pursuing remote maintenance monitoring concepts with the objectives of maximizing personnel resource utilization and of improving system availability. The Remote Maintenance Monitor System (RMMS) is being formulated to provide such capabilities to RCAG facilities, navigation (VORTAC) facilities, and En Route Surveillance Radars (ARSRs). Current concepts propose the use of a central processor to be located at the ARTCC. All maintenance information would be transmitted from the above facilities via existing communication links to the processor for storage and processing. The main capabilities sought are: monitoring equipments and alarms, remote certification, automated recordkeeping, trend analysis, and remote control of power sources.

In the Near Term it is expected that the Remote Maintenance Monitor System (RMMS) will be available to provide remote monitoring and certification of RCAGs. In the Far Term it is expected that the same capability will be available for en route surveillance sites and navigation aids. See 2.3.15 for further information.

Additional Potential Improvements

Additional potential improvements in Management of Traffic Load (Local Flow Control) would provide Local Flow Controllers with printed or displayed information such as:

- automatic counts of aircraft that are predicted to be in sectors, over fixes, on airways, etc.
- automatic monitoring of the above counts to detect potential overload situations,
- automatic warning of potential overload situations, and
- automatic generation of recommended solutions to overload situations

No work is currently planned or underway in this area.

AERA (Automated En Route Air Traffic Control) is an additional potential improvement that could have a significant effect on both Management of Traffic Flow Near Terminals (En Route Metering) and Planning of Conflict-Free Paths (Flight Plan Conflict Probe). AERA would solve routine spacing and sequencing problems and implement the solutions through automatically-generated messages sent to pilots via Data Link or voice radio. AERA would also provide aid for non-routine problems. Experimental work is currently underway with AERA.

Another potential improvement is CMA (Control Message Automation). CMA would provide the link between the ARTCC and DABS data link. CMA would handle functions such as formatting, bookkeeping, and the establishment and use of priorities for

data link messages. CMA would handle messages that may be generated through functions/features such as Conflict Alert, Conflict Resolution Advisory, ETABS, etc.

Another potential change is the replacement/augmentation of the en route computers (9020, CDC). As air traffic volume increases and software capabilities are added to the en route system, the possibility of exceeding current hardware capabilities increases. An added incentive for change results from the equipment growing older, and maintenance costs rising. See 2.3.12 for further information.

Access of the CWSU to all of the air-ground frequencies of the Center may be provided. The meteorologist would then be capable of monitoring weather (PIREP) communications between controllers and pilots and would be able to communicate directly with the pilot for the acquisition of more specific weather information.

In the future, it may be desirable to exchange Conflict Alert and Conflict Resolution Advisory information between facilities (ARTCC and ARTCC; ARTCC and TRACON). This would be done so that both facilities could have the same conflict information for aircraft that are at, or near, the boundary between the two facilities. As currently performed, the Conflict Alert function at one facility might declare an alert for a pair of aircraft, but the Conflict Alert function at the adjacent facility might not declare an alert until a later time, or might not declare an alert at all. This could occur because of differences in scan rates, separation standards, conflict alert algorithms, and use or non-use of flight intent data. Similarly, in the future, one facility might provide a

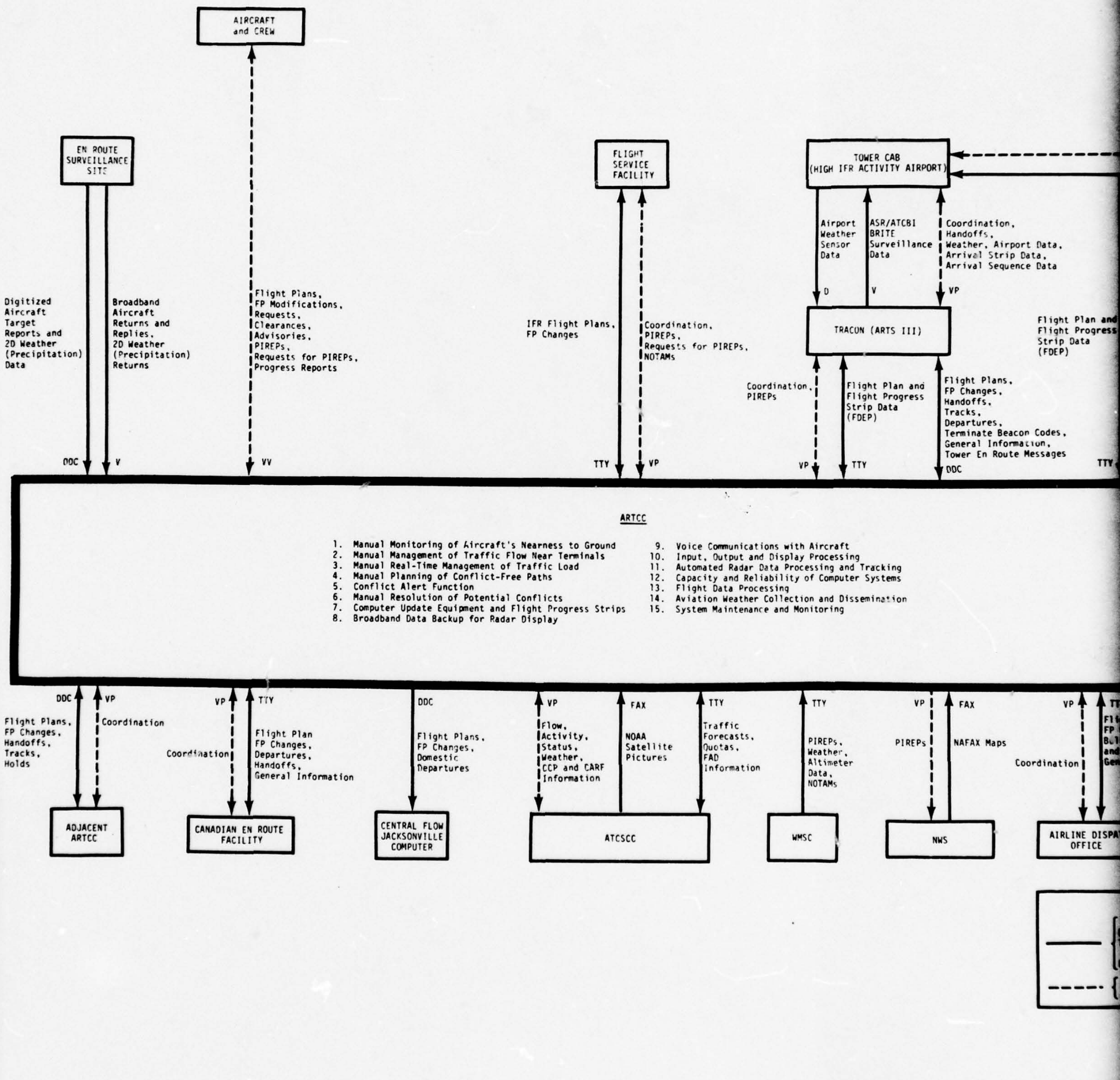
conflict resolution advisory before another facility, and the maneuvers recommended in the two advisories might not be the same. Considering this lack of common conflict information, it may be desirable to exchange such information between adjacent facilities.

Another Additional Potential Improvement is the enhancement of the "R" Position Console. A capability similar to that provided to the "D" and "A" Positions through ETABS appears to be desirable. Investigation and experimentation are underway on the use of tabular display panels with touch input capabilities at the "R" Position. Investigation and experimentation are also underway on the use of color cathode ray tubes instead of the present monochromatic (black and white) tubes for PVDs.

A number of potential improvements are being considered in connection with DARC. The possibility of isolating Radar Data Processing (RDP) from Flight Data Processing (FDP) within the CCC is being investigated. The goal would be to remove RDP from the CCC and perform it within DARC. This removal of the RDP load from the CCC would allow the CCC to perform FDP even if there were substantial increases in traffic load and/or there were fewer storage elements available. DARC II is being considered as an improvement that would provide two-way communication between the CCC and DARC. Consideration is being given to an Upgraded DARC that would have full RDP and FDP capability including tracking, mosaicking, conflict alert, conflict resolution advisory, etc.

2.2 En Route Facilities System Connectivity

Figures 2-1, 2-2, and 2-3 show respectively, the Current, Near Term, and Far Term connections between an En Route Facility (ARTCC)


AIRCRAFT and CREW
EN ROUTE SURVEILLANCE SITE
FLIGHT SERVICE FACILITY
TOWER CAB (HIGH IFR ACTIVITY AIRPORT)
Digitized Aircraft Target Reports and 2D Weather (Precipitation) Data
Broadband Aircraft Returns and Replies, 2D Weather (Precipitation) Returns
Flight Plans, FP Modifications, Requests, Clearances, Advisories, PIREPs, Requests for PIREPs, Progress Reports
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Airport Weather Sensor Data
ASR/ATCBI BRITE Surveillance Data
Coordination, Handoffs, Weather, Airport Data, Arrival Strip Data, Arrival Sequence Data
D
V
VP
TRACON (ARTS III)
Flight Plan and Flight Progress Strip Data (FDEP)
Coordination, PIREPs
Flight Plan and Flight Progress Strip Data (FDEP)
Flight Plans, FP Changes, Handoffs, Tracks, Departures, Terminate Beacon Codes, General Information, Tower En Route Messages
DDC
V
VV
TTY
VP
VP
TTY
DDC
TTY
ARTCC
1. Manual Monitoring of Aircraft's Nearness to Ground
2. Manual Management of Traffic Flow Near Terminals
3. Manual Real-Time Management of Traffic Load
4. Manual Planning of Conflict-Free Paths
5. Conflict Alert Function
6. Manual Resolution of Potential Conflicts
7. Computer Update Equipment and Flight Progress Strips
8. Broadband Data Backup for Radar Display
9. Voice Communications with Aircraft
10. Input, Output and Display Processing
11. Automated Radar Data Processing and Tracking
12. Capacity and Reliability of Computer Systems
13. Flight Data Processing
14. Aviation Weather Collection and Dissemination
15. System Maintenance and Monitoring
DDC
VP
Flight Plans, FP Changes, Handoffs, Tracks, Holds
Coordination
VP
TTY
Coordination
Flight Plan FP Changes, Departures, Handoffs, General Information
DDC
Flight Plans, FP Changes, Domestic Departures
VP
Flow, Activity, Status, Weather, CCP and CARF Information
FAX
NOAA Satellite Pictures
TTY
Traffic Forecasts, Quotas, FAD Information
TTY
PIREPs, Weather, Altimeter Data, NOTAMs
VP
PIREPs
FAX
NAFAX Maps
VP
Coordination
ADJACENT ARTCC
CANADIAN EN ROUTE FACILITY
CENTRAL FLOW JACKSONVILLE COMPUTER
ATCSCC
WMSC
NWS
AIRLINE DISPA
OFFICE

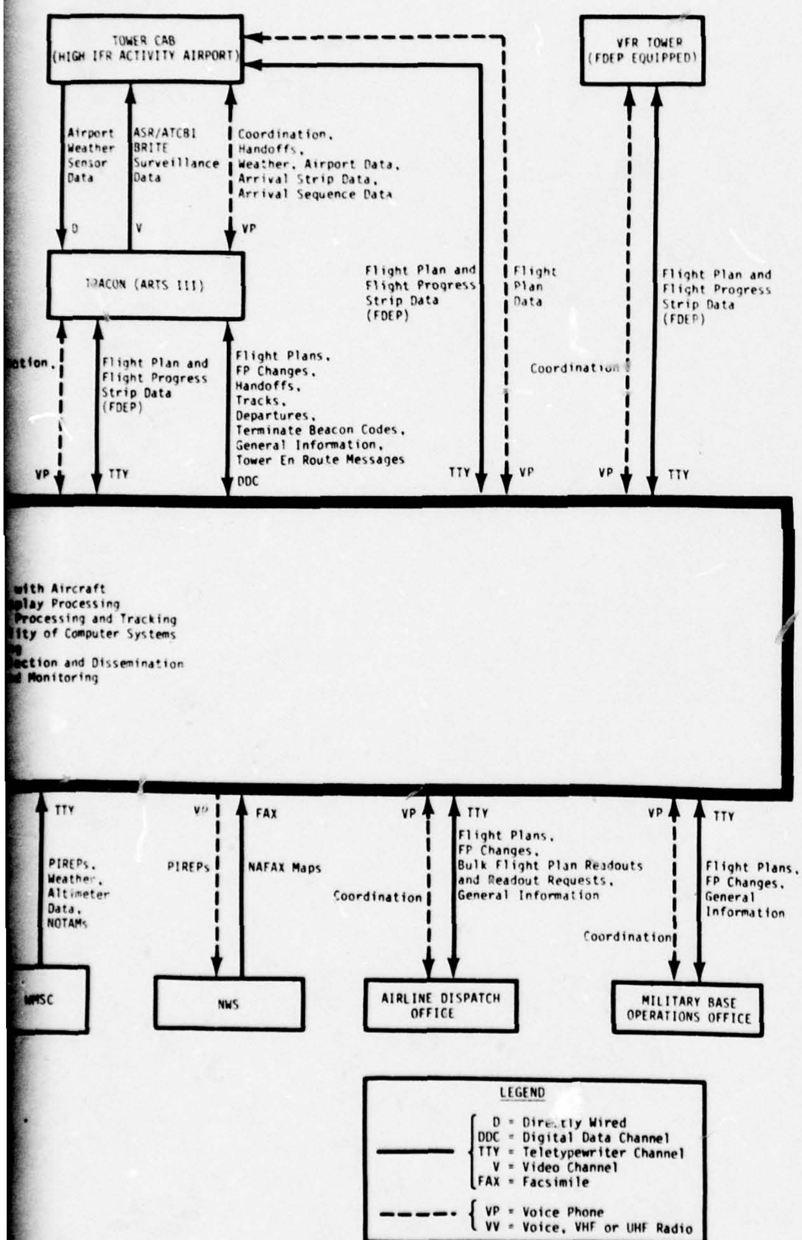
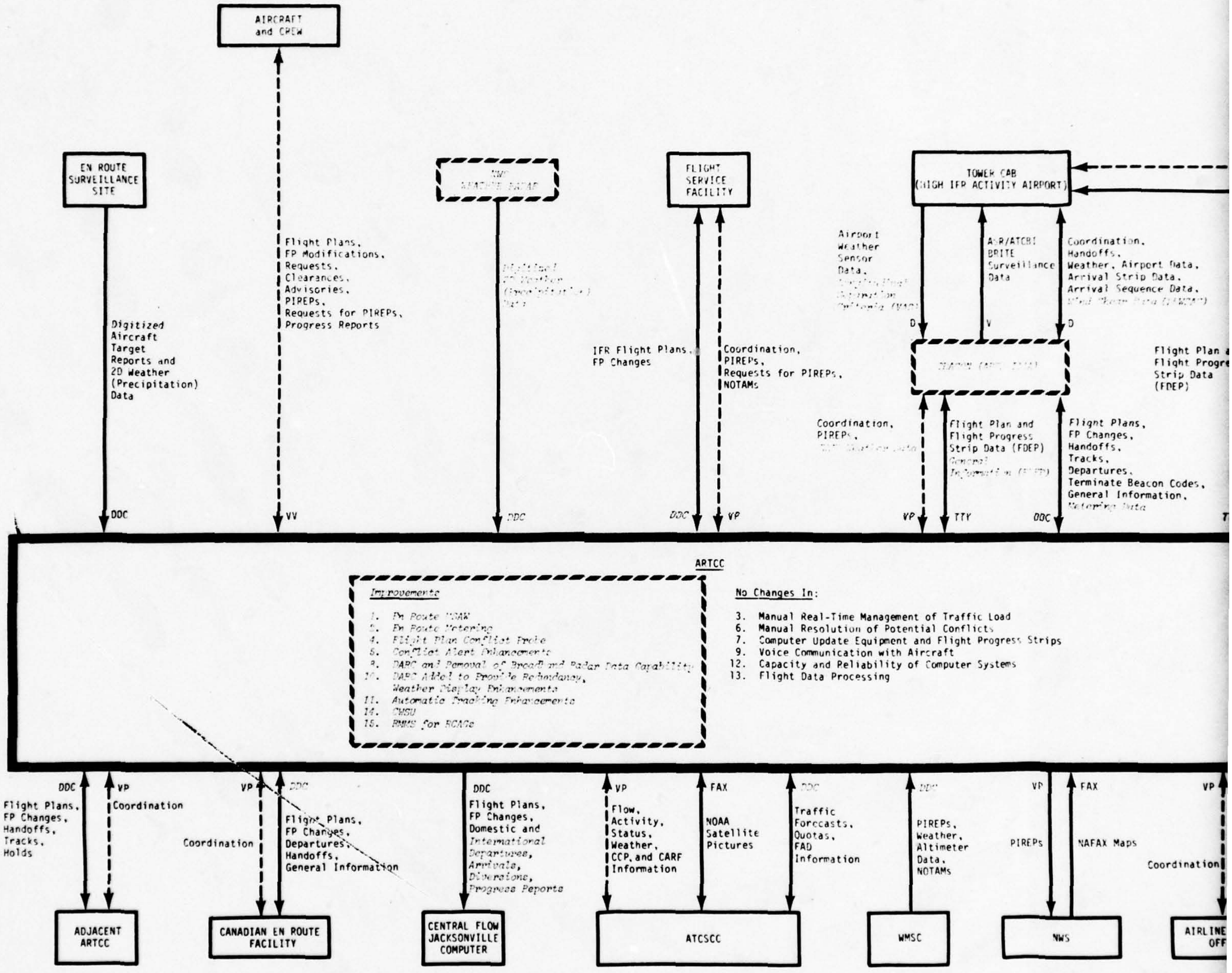


FIGURE 2-1
CURRENT ARTCC CONNECTIVITY DIAGRAM

2



NOTE: **Changes from the Current system to the Near Term are indicated in *italics*.**

LEGEND

Solid line:
- D = Directly Wired
- DDC = Digital Data Channel
- TTY = Teletypewriter Channel
- FAX = Facsimile
- V = Video Channel

Dashed line:
- VP = Voice Phone
- FF = Face to Face
- VV = Voice, VHF or UHF Radio

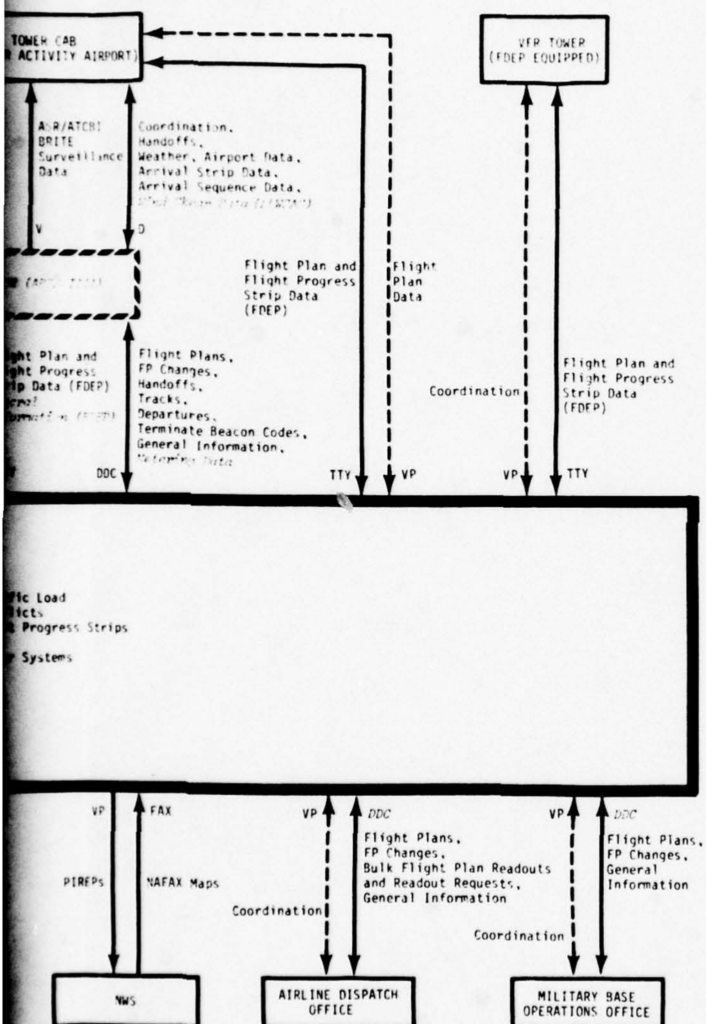
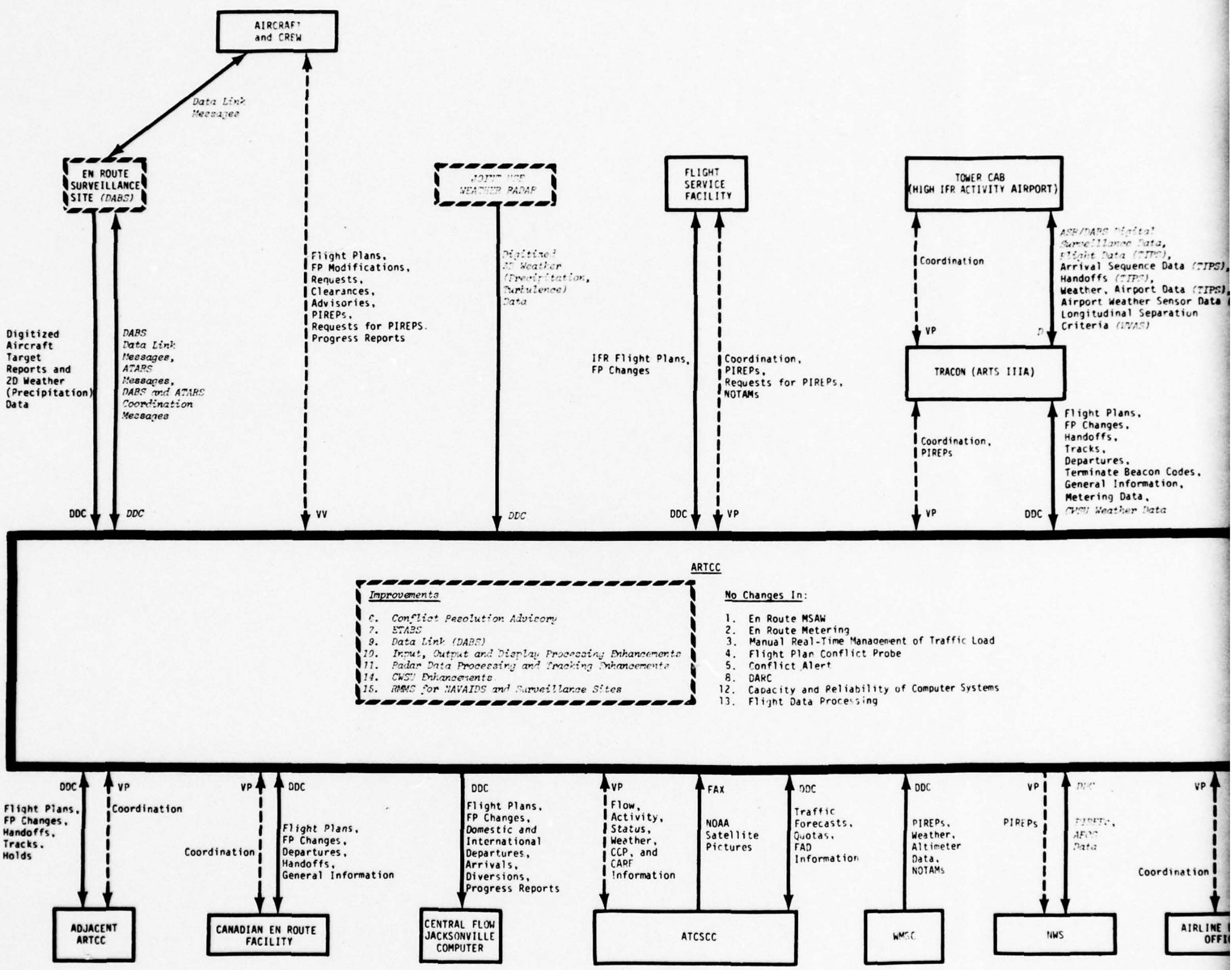


FIGURE 2-2
NEAR TERM ARTCC CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

LEGEND

Solid line:
- D = Directly Wired
- DDC = Digital Data Channel
- TTY = Teletypewriter Channel
- FAX = Facsimile
- V = Video Channel

Dashed line:
- VP = Voice Phone
- FF = Face to Face
- VV = Voice, VHF or UHF Radio

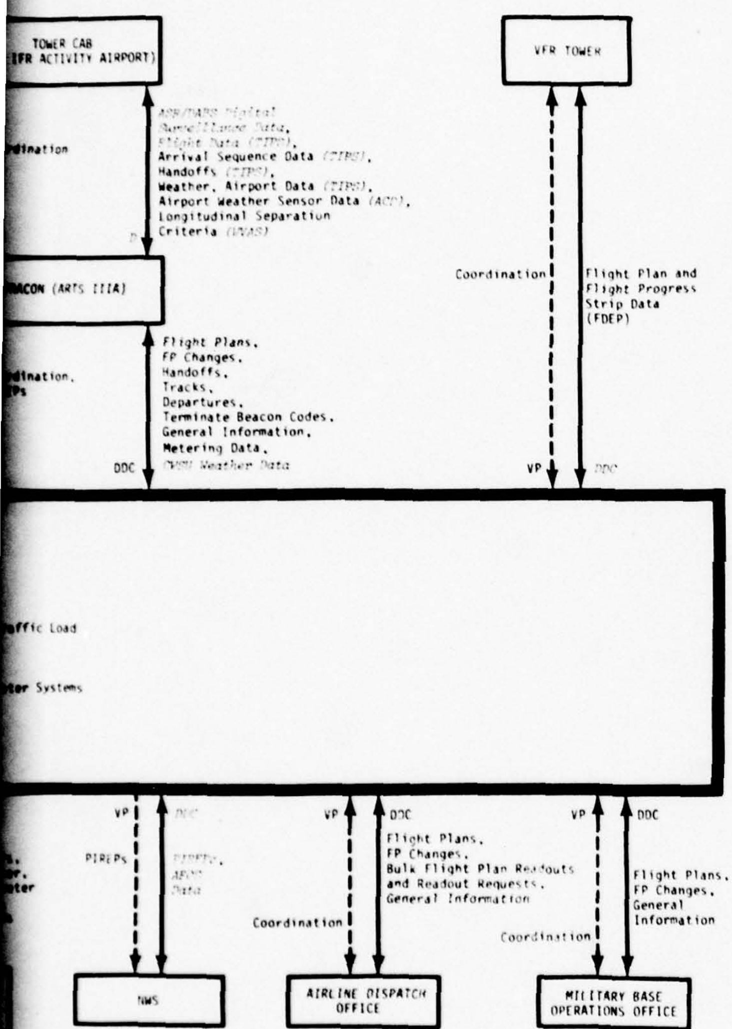


FIGURE 2-3
FAR TERM ARTCC CONNECTIVITY DIAGRAM

2

and other elements of the ATC system. The principal changes in connectivity from the Current system to the Near Term system are shown in italic type in Figure 2-2. Changes in complete functions and groups of improvements are further emphasized by being enclosed in blocks outlined with heavy, broken lines. Similarly, italics and heavy, broken lines are used in Figure 2-3 to indicate the principal changes in connectivity from the Near Term system to the Far Term system. These changes are briefly described in the following paragraphs.

Near Term

In the Near Term, the broadband surveillance data would be eliminated. It would no longer be needed once DARC is implemented and dual common digitizers (CD-2) are implemented at the surveillance sites. Tower En Route messages that currently are routed from one TRACON to another through the host ARTCC would be eliminated because of the availability of direct TRACON to TRACON communication through NADIN (National Airspace Data Interchange Network). With the implementation of En Route MSAW in the Near Term, EMSAW advisory messages would be sent from the ARTCC to aircraft via voice radio. Information on progress reports, arrivals, and diversions would be sent to the ATCSCC from the ARTCC for use in Central Flow Control calculations. Line speeds for communications between the ARTCC and some other elements would be increased in the Near Term. The transmission speed to and from FDEPs (Flight Data Entry and Printout equipment) would be increased so that it would be approximately double the current 75 baud rate. Through NADIN, the transmission speed to and from Flight Service Facilities, Airline Dispatch Offices, and Military Base Operations Offices would be increased to 2400 bits per second from the current teletypewriter speed. Center Weather Service Units (CWSU) would be implemented at all ARTCCs. Digitized three-dimensional

weather data is expected to be sent from NWS Weather Radars and would be available for display on plan view displays in the CWSUs. The Remote Maintenance Monitor System (RMMS) would be available for remote monitoring and certification of RCAGs.

Except as noted above, the following improvements are internal to the ARTCC and would cause no significant changes in connectivity: En Route MSAW, En Route Metering, Flight Plan Conflict Probe, Conflict Alert Enhancements, DARC, and Automatic Tracking Enhancements.

Far Term

Data Link capabilities would be available through DABS. The ARTCC would be able to send messages to the surveillance sites for uplinking to aircraft, and would receive (from the surveillance site) messages that have been downlinked from aircraft. The ARTCC would continue to receive two-dimensional digitized weather data from the surveillance site, but would also receive digitized three-dimensional turbulent weather data from Joint Use En Route Weather Radar Sites. The en route surveillance sites would also provide the ARTCC with information concerning ATARS warnings and ATARS recommended maneuvers that have been sent to aircraft, as well as pilots' responses to such messages. RMMS would be provided with the additional capability of remote monitoring and certification of en route surveillance sites and navigation aids. The capability of CWSUs would be improved through their inclusion within AFOS (Automation of Field Operations and Services). Also in the Far Term, the ARTCC would no longer send flight progress strip data to FDEPs in TRACONs and TRACABs. Instead, TIPS would use the Flight Plans that it receives from the ARTCC to prepare flight progress data to be

displayed to Tower Cab and TRACON/TRACAB controllers. PIREPs (Pilot Weather Reports) and Requests for PIREPs from the WMSC would be sent through NADIN digital data communication channels instead of by voice. Except as noted above, the following improvements are internal to the ARTCC and would cause no significant changes in connectivity: Conflict Resolution Advisory function; ETABS; Input, Output, and Display Processing enhancements; and Radar Data Processing and Tracking enhancements.

2.3 En Route Facilities Information Flow

Figures 2-4, 2-5, and 2-6 show respectively the Current, Near Term, and Far Term information flow between an En Route Facility (ARTCC) and other elements of the ATC system. In each figure, the ARTCC is shown as a large box in the middle. The inputs to the ARTCC are shown to the left of the box; the outputs from the ARTCC are shown to the right.

The box itself contains the names of most of the major functions that are performed within the ARTCC and very brief descriptions of how the named functions are expected to be performed at the end of the period (Current, Near Term, or Far Term) for which the figure has been prepared. The inputs and outputs that are listed are the general types of inputs and outputs for an ARTCC, not the total set of input and output message types.

The principal changes in information flow and in functions from the Current system to the Near Term system are shown in italic type in Figure 2-5. Similarly, italics are used in Figure 2-6 to indicate the principal changes from the Near Term system to the Far Term system. The changes in functions, the inputs to the functions, and the outputs from the functions are described in the following paragraphs.

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON/TRACAB (ARTS III, ARTS II, or TPX-42)
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDEP)
- General Information Messages (FDEP)
- Tower En Route Messages
- PIREPs
- Coordination

From Tower Cab
- Flight Plan Data (FDEP)
- Coordination

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- *Flight Plans, FP Changes*
- Bulk FP Readout Requests

From Non-U.S. En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather Data (WFMU)
  - Broadband (Video) Aircraft and Two-dimensional Weather Returns (range, azimuth)
- ATCRBS
  - Digitized Aircraft Target Reports (range, azimuth, identification, altitude)
  - Broadband (Video) Aircraft Replies (range, azimuth, identification, altitude)

From National Weather Service
- *NAFAX (Alden Facsimile) Maps*

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Traffic Quotas
- FAD Information
- NOAA Satellite Pictures

From Flight Service Facility (Flight Service Station)
- Requests for PIREPs
- IFR Flight Plans, FP Changes
- NOTAMs

From Weather Message Switching Center
- Weather and Altimeter Data
- PIREPs
- NOTAMs

Current En Route Facility

F U N C T I O N S

1. Monitoring Nearness to Ground
   Controllers manually check aircraft for safe altitudes
2. Management of Traffic Flow Near Terminals
   Random arrivals at feeder fixes
   Manual metering to feeder fixes
3. Real Time Management of Traffic Load
   Manual Local Flow Control
4. Planning of Conflict-Free Paths
   Controllers manually compare future times and altitudes over fixes
5. Conflict Alert
   CCC Predicts potential conflicts
6. Resolution of Immediate Potential Aircraft Conflicts
   Controllers manually evaluate and resolve potential conflicts
7. Entry and Display of Controllers' Flight Data
   Computer Entry and Readout Devices
   Flight Strip Printers
8. Backup Surveillance Display Capability
   Broadband search radar and beacon
9. Communication with Aircraft
   Voice Radio
10. Input, Output, and Display Processing
    Through CCC and Data Entry and Display Subsystems
11. Radar Data Processing and Automatic Tracking
    Through CCC
12. Flight Data Processing
    Processing of flight data to provide information that aids: Controllers, Flight Plan Aided Tracking (FLAT), etc.
13. Aviation Weather Collection and Dissemination
    Not consolidated in ARTCC
14. System Maintenance and Monitoring
    SMM Console; manual on-site maintenance and certification
15. Adaptation
    Storage of environmental data (fixes, map boundaries, routes, etc.) to be used in processing
16. Beacon Code (ATCRBS) Allocation
    Automatic assignment and bookkeeping of the identification *codes (Mode 3/A) for aircraft for discrete, non-discrete,* specific ARTCCs, specific altitudes, departures, internal flights, external flights, military, terminal, VFR, oceanic, etc.

To Adjacent ARTCC
- Flight Plans, FP
- Handoff and Track
- Holds

To TRACON/TRACAB (ARTS
- Flight Plans, FP
- Handoff and Track
- Flight Plan and
- *General Informati*
- Tower En Route M
- PIREPs
- Coordination

To Tower Cab
- Flight Plan and
- Coordination

To Military Base Opera
- General Informati

To Airline Dispatch O
- General Informati
- Bulk Flight Plan

To Non-U.S. En Route
- Flight Plans, FP
- General Informati
- Departure Messag
- Handoff Messages

To Aircraft (Air Crew
- Clearances
- FP Modifications
- Instructions, Ad
- Requests for PI

To ATCSCC
- Requests for Ass Impending Cala
- Flow Control Dat
- Status and Weath
- Activity Message Flight Plans, Remove Strip M

To Flight Service Fac
- PIREPs

To National Weather S
- PIREPs

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

To TRACON/TRACAB (ARTS III, ARTS II, or TPX-42)
- Flight Plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Progress Strip Data (FDEP)
- General Information Messages
- Tower En Route Messages
- PIREPs
- Coordination

To Tower Cab
- Flight Plan and Flight Progress Strip Data (FDEP)
- Coordination

To Military Base Operations Office
- General Information Messages

To Airline Dispatch Office
- General Information Messages
- Bulk Flight Plan Readouts

To Non-U.S. En Route Facility
- Flight Plans, FP Changes
- General Information Messages
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To ATCSCC
- Requests for Assistance in Handling Calamities or Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for Pacing Airports (Non-Air-Carrier Flight Plans, Departure Messages (Domestic Flights), Remove Strip Messages)

To Flight Service Facility (Flight Service Station)
- PIREPs

To National Weather Service
- PIREPs

FIGUARE 2-4
CURRENT EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM

2

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON/TRACAB (ARTS III, ARTS II, or TPX-42)
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDEP)
- General Information Messages (FDEP)
- PIREPs
- Coordination
- *Metering Data*

From Tower Cab
- Flight Plan Data (FDEP)
- Coordination

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- Flight Plans, FP Changes
- Bulk FP Readout Requests

From Non-U.S. En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather Data (*CD-2 Common Digitizer)*
- ATCRBS
  - Digitized Aircraft Target Reports (range, azimuth, identification, altitude)

From NWS Weather Radar
- *Digitized Three-dimensional Weather Data*

From National Weather Service
- NAFAX (Alden Facsimile) Maps

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Traffic Quotas
- FAD Information
- NOAA Satellite Pictures

From Flight Service Facility
- IFR Flight Plans, FP Changes
- Requests for PIREPs
- NOTAMs
- Coordination

From Weather Message Switching Center
- Weather and Altimeter Data
- PIREPs
- NOTAMs

Near Term En Route Facility

F U N C T I O N S

1. En Route MSAW
   CCC would automatically check aircraft for safe altitudes
2. *En Route Metering*
   CCC would provide advisories to controllers to cause orderly arrivals of aircraft at feeder fixes in a fuel-conservative manner
   CCC would plan based on multiple runways, etc.
3. Real-Time Management of Traffic Load
   Manual Local Flow Control (no change)
4. *Flight Plan Conflict Probe*
   CCC would look for potential conflicts many minutes in advance
5. *Conflict Alert Enhancements*
   Would function with Mode C intruder aircraft
   Few false alerts with full altitude coverages
6. Resolution of Immediate Potential Aircraft Conflicts
   Controllers manually evaluate and resolve potential conflicts
7. Entry and Display of Controllers' Flight Data
   Computer Entry & Readout Devices (no change)
   Flight Strip Printers (no change)
8. *DARC*
   Will provide data blocks for beacon aircraft
   Will allow limited keyboard entry of data
   Will provide position symbols for search & beacon targets
9. Communication with Aircraft
   Voice radio (no change)
10. Input, Output, and Display Processing
    Backup through DARC
11. Radar Data Processing and Automatic Tracking
    Through CCC with DARC as backup; enhanced altitude tracking
12. Flight Data Processing
    Processing of flight data to provide information that aids: Controllers, Flight Plan Aided Tracking (FLAT), etc. (no change)
13. *Aviation Weather Collection & Dissemination*
    CWSU would consolidate this activity
14. *System Maintenance and Monitoring*
    RMMS would provide remote maintenance and certification of NCAGs
15. Adaptation
    Storage of environmental data (fixes, map boundaries, routes, etc.) to be used in processing (no change)
16. Beacon Code (ATCRBS) Allocation
    Automatic assignment and bookkeeping of the identification codes for aircraft (no change)

Italics = change from previous version of system

To Adjacent ARTC
- Flight Plan
- Handoff and
- Holds

To TRACON/TRACAB
- Flight Pla
- Handoff and
- Flight Plan
- General Inf
- PIREPs
- Coordinatio
- *CWSU Weather*
- *Metering Da*

To Tower Cab
- Flight Plan
- Coordinatio

To Military Base
- General Inf

To Airline Dispa
- General Inf
- Bulk Flight

To Non-U.S. En R
- Flight Plan
- General Inf
- Departure M
- Handoff Mes

To Aircraft (Air
- Clearances
- FP Modifica
- Instruction,
- Requests fo

To ATCSCC
- Requests for
  Impending
- Flow Control
- Status and
- Activity Me
  Airports
  Messages
  Remove St
- *Arrival and*
- *Progress Re*

To Flight Servic
- PIREPs
- Coordinatio

To National Weath
- PIREPs

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

To TRACON/TRACAB (ARTS III, ARTS II, or TPX-42)
- Flight Plans, FP Changes
- Handoff and Track Messages
- *Flight Plan and Flight Progress Strip Data (FDEP)*
- General Information Messages
- PIREPs
- Coordination
- *CWSU Weather Data*
- *Metering Data*

To Tower Cab
- Flight Plan and Flight Progress Strip Data (FDEP)
- Coordination

To Military Base Operations Office
- General Information Messages

To Airline Dispatch Office
- General Information Messages
- Bulk Flight Plan Readouts

To Non-U.S. En Route Facility
- Flight Plans, FP Changes
- General Information Messages
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instruction, Advisories
- *Requests for PIREPs*

To ATCSCC
- Requests for Assistance in Handling Calamities or Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for *Expanded Number of Selected* Airports (Non-Air-Carrier Flight Plans, Departure Messages (Domestic *and International* Flights), Remove Strip Messages)
- *Arrival and Diversion Messages*
- *Progress Reports*

To Flight Service Facility
- PIREPs
- *Coordination*

To National Weather Service
- PIREPs

FIGURE 2-5
NEAR TERM EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM

2

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON/TRACAB (ARTS III, ARTS II, or TPX-42 *with TIPS Data Interface)*
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data *(TIPS)*
- General Information Messages *(TIPS)*
- PIREPs
- Coordination
- Metering Data

From Tower Cab
- Flight Plan Data (FDEP)
- Coordination

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- Flight Plans, FP Changes
- Bulk FP Readout Requests

From Non-U.S. En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew, *Data Link Available*)
- Flight Plans, Requests for FP Changes
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather Data (CD-2 Common Digitizer)
- *DABS*
  - *Digitized DABS/ATCRBS Aircraft Target Reports (range, azimuth, identification, altitude)*
  - *DABS, ATARS Coordination Messages*
- *DABS Data Link*
- *DABS ATARS*
  - *Controller Notification of Collision Avoidance Advisories*

From Joint Use En Route Weather Radar Site
- *Digitized Three-dimensional Weather Radar*

From National Weather Service
- NAFAX (Alden Facsimile) Maps
- *AFOS Data*

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Traffic Quotas
- FAD Information
- NOAA Satellite Pictures

From Flight Service Facility
- IFR Flight Plans, FP Changes
- Requests for PIREPs
- NOTAMs
- Coordination

From Weather Message Switching Center
- Weather and Altimeter Data
- PIREPs
- NOTAMs

Far Term En Route Facility

FUNCTIONS

1. En Route MSAW
   CCC would automatically check aircraft for safe altitudes (no change)
2. En Route Metering
   CCC would provide advisories to controllers to cause orderly arrivals of aircraft at feeder fixes in a fuel-conservative manner (no change)
3. Real-Time Management of Traffic Load
   Manual Local Flow Control (no change)
4. Flight Plan Conflict Probe
   CCC would look for potential conflicts many minutes in advance (no change)
5. Conflict Alert
   Would function with Mode C intruder aircraft (no change)
   Few false alerts with full altitude coverage (no change)
   ATARS & BCAS would provide related improvements
6. *Conflict Resolution Advisory*
   CCC would determine maneuvers to avoid conflict
   CCC would provide controllers with resolution advisory information
   ATARS & BCAS would provide related improvements
7. *ETABS*
   Tabular display devices would eliminate need for printed flight strips
   Alphanumeric keyboards and touch entry devices (on displays)
   Could provide flight data base to CCC after CCC failure
8. DARC
   Will provide data blocks for beacon aircraft (no change)
   Will allow limited keyboard entry of data (no change)
   Will provide position symbols for search and beacon targets (no change)
9. *Communication with Aircraft by Voice Radio, Data Link Available*
   Possible applications of Data Link:
   Uplinking of Conflict Resolution advisories, Metering advisories, MSAW warnings, etc.
   Downlinking of compliance with advisories, requests for altimeter settings, etc.
   Data Link would require CCC to perform some additional processing
10. Input, Output, and Display Processing
    CCC Processing for FDEP strips offloaded through TIPS
    Partial offloading of CCC processing through ETABS
    Display of Digitized Turbulent Weather
11. Radar Data Processing and Automatic Tracking
    Addition of DABS would improve surveillance data used by ARTCC
12. Flight Data Processing
    Processing of flight data to provide information that aids: Controllers, Flight Plan Aided Tracking (FLAT), etc. (no change)
13. *Aviation Weather Collection & Dissemination*
    CWSU enhancements such as its inclusion in AFOS
14. *System Maintenance and Monitoring*
    RMMS expanded to provide remote maintenance and certification of en route surveillance sites and navigation aids
15. Adaptation
    Storage of environmental data (fixes, map boundaries, routes, etc.) to be used in processing (no change)
16. Beacon Code (ATCRBS) Allocation
    Automatic assignment and bookkeeping of the identification codes for aircraft (no change)

Italics = change from previous version of system

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Change
- Handoff and Track Messa
- Holds

To TRACON/TRACAB (ARTS III,
TIPS Data Interface)
- Flight Plans, FP Change
- Handoff and Track Messa
- General Information Mes
- Coordination
- CWSU Weather Data
- Metering Data

To Tower Cab
- *Flight Plan Data (TIPS* Strip Data (FDEP)
- Coordination

To Military Base Operations
- General Information Mes

To Airline Dispatch Office
- General Information Mes
- Bulk Flight Plan Readou

To Non-U.S. En Route Facility
- Flight Plans, FP Change
- General Information Mes
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew, *Data*
- Clearances
- FP Modifications
- Instructions, Advisori
- Requests for PIREPs

To En Route Surveillance Site
- *DABS*
  - *DABS, ATARS Coordina*
- *DABS Data Link*

To ATCSCC
- Requests for Assistance Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for Airports (Non-Air-Car Messages, Remove Stri
- Arrival and Diversion
- Progress Reports

To Flight Service Facility
- PIREPs
- Coordination

To National Weather Service
- PIREPs
- *AFOS Data*

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON/TRACAB (ARTS III, ARTS II, or TPX-42 *with TIPS Data Interface)*
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data *(TIPS)*
- General Information Messages *(TIPS)*
- PIREPs
- Coordination
- Metering Data

From Tower Cab
- Flight Plan Data (FDEP)
- Coordination

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- Flight Plans, FP Changes
- Bulk FP Readout Requests

From Non-U.S. En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew, *Data Link Available)*
- Flight Plans, Requests for FP Changes
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather Data (CD-2 Common Digitizer)
- *DABS*
  - *Digitized DABS/ATCRBS Aircraft Target Reports (range, azimuth, identification, altitude)*
  - *DABS, ATARS Coordination Messages*
- *DABS Data Link*
- *DABS ATARS*
  - *Controller Notification of Collision Avoidance Advisories*

From Joint Use En Route Weather Radar Site
- *Digitized Three-dimensional Weather Radar*

From National Weather Service
- NAFAX (Alden Facsimile) Maps
- *AFOS Data*

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Traffic Quotas
- FAD Information
- NOAA Satellite Pictures

From Flight Service Facility
- IFR Flight Plans, FP Changes
- Requests for PIREPs
- NOTAMs
- Coordination

From Weather Message Switching Center
- Weather and Altimeter Data
- PIREPs
- NOTAMs

Far Term En Route Facility

FUNCTIONS

1. En Route MSAW
   CCC would automatically check aircraft for safe altitudes (no change)
2. En Route Metering
   CCC would provide advisories to controllers to cause orderly arrivals of aircraft at feeder fixes in a fuel-conservative manner (no change)
3. Real-Time Management of Traffic Load
   Manual Local Flow Control (no change)
4. Flight Plan Conflict Probe
   CCC would look for potential conflicts many minutes in advance (no change)
5. Conflict Alert
   Would function with Mode C intruder aircraft (no change)
   Few false alerts with full altitude coverage (no change)
   ATARS & BCAS would provide related improvements
6. *Conflict Resolution Advisory*
   CCC would determine maneuvers to avoid conflict
   CCC would provide controllers with resolution advisory information
   ATARS & BCAS would provide related improvements
7. *ETABS*
   Tabular display devices would eliminate need for printed flight strips
   Alphanumeric keyboards and touch entry devices (on displays)
   Could provide flight data base to CCC after CCC failure
8. DARC
   Will provide data blocks for beacon aircraft (no change)
   Will allow limited keyboard entry of data (no change)
   Will provide position symbols for search and beacon targets (no change)
9. *Communication with Aircraft by Voice Radio, Data Link Available*
   Possible applications of Data Link:
   Uplinking of Conflict Resolution advisories, Metering advisories, MSAW warnings, etc.
   Downlinking of compliance with advisories, requests for altimeter settings, etc.
   Data Link would require CCC to perform some additional processing
10. Input, Output, and Display Processing
    CCC Processing for FDEP strips offloaded through TIPS
    Partial offloading of CCC processing through ETABS
    Display of Digitized Turbulent Weather
11. Radar Data Processing and Automatic Tracking
    Addition of DABS would improve surveillance data used by ARTCC
12. Flight Data Processing
    Processing of flight data to provide information that aids: Controllers, Flight Plan Aided Tracking (FLAT), etc. (no change)
13. *Aviation Weather Collection & Dissemination*
    CWSU enhancements such as its inclusion in AFOS
14. *System Maintenance and Monitoring*
    RMMS expanded to provide remote maintenance and certification of en route surveillance sites and navigation aids
15. Adaptation
    Storage of environmental data (fixes, map boundaries, routes, etc.) to be used in processing (no change)
16. Beacon Code (ATCRBS) Allocation
    Automatic assignment and bookkeeping of the identification codes for aircraft (no change)

Italics = change from previous version of system

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Change
- Handoff and Track Messa
- Holds

To TRACON/TRACAB (ARTS III, *TIPS Data Interface)*
- Flight Plans, FP Change
- Handoff and Track Mess
- General Information Mes
- Coordination
- CWSU Weather Data
- Metering Data

To Tower Cab
- *Flight Plan Data (TIPS* Strip Data (FDEP)
- Coordination

To Military Base Operations
- General Information Mes

To Airline Dispatch Office
- General Information Mes
- Bulk Flight Plan Readou

To Non-U.S. En Route Facility
- Flight Plans, FP Change
- General Information Mes
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew, *Data*
- Clearances
- FP Modifications
- Instructions, Advisorie
- Requests for PIREPs

To En Route Surveillance Sit
- *DABS*
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- *DABS Data Link*

To ATCSCC
- Requests for Assistance Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for Airports (Non-Air-Car Messages, Remove Stri
- Arrival and Diversion M
- Progress Reports

To Flight Service Facility
- PIREPs
- Coordination

To National Weather Service
- PIREPs
- *AFOS Data*

OUTPUTS

ent ARTCC
ght Plans, FP Changes
doff and Track Messages
ds

M/TRACAB (ARTS III, ARTS II, or TPX-42 *with*
Interface)
ght Plans, FP Changes
doff and Track Messages
eral Information Messages
rdination
U Weather Data
oring Data

Cab
ght *Plan Data (TIPC* or FDEP) and Flight Progress
Strip Data (FDEP)
rdination

tary Base Operations Office
eral Information Messages

ine Dispatch Office*
eral Information Messages
h Flight Plan Readouts

.S. En Route Facility
ght Plans, FP Changes
eral Information Messages
arture Messages
doff Messages

raft (Air Crew, *Data Link Available*)
arances
Modifications
tructions, Advisories
uests for PIREPs

ute Surveillance Site
S
DABS, ATARS Coordination Messages
S *Data Link*

CC
uests for Assistance in Handling Calamities or
Impending Calamities
w Control Data
tus and Weather Data
tivity Messages for Expanded Number of Selected
Airports (Non-Air-Carrier Flight Plans, Departure
Messages, Remove Strip Messages)
rival and Diversion Messages
gress Reports

ht Service Facility
REPs
rdination

onal Weather Service
REPs
OS *Data*

FIGURE 2-6
FAR TERM EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM

2

2.3.1 Monitoring Nearness to Ground

In the current system, controllers manually compare aircraft altitudes to minimum safe altitudes in order to detect dangerous situations. Controllers then advise the aircraft air crews of the potential dangers through voice radio.

In the Near Term, En Route MSAW is expected to be implemented. It would provide controllers with visual warnings when aircraft are at altitudes that are too low for the area in which the aircraft are operating. All outputs would go to controllers within the ARTCC. The inputs that would be required in order to perform the function would come from information that would (in the future) be available in the CCC. Inputs that would be required are:

- minimum safe altitudes for the areas being probed. Obtained from the CCC's Adaptation data base.
- aircraft altitudes. Obtained from the CCC's Automatic Tracking program.

The software would compare the present altitude for each aircraft with the minimum safe altitudes for the area in which the aircraft is operating and for the areas in which the aircraft would be operating in the near future. The program would detect instances in which an aircraft is now, or in the near future would be, below the minimum safe altitude. Outputs that would be provided are:

- displayed warnings. Provided on the PVDs of the appropriate controllers.

No Far Term changes are included in the current plans.

2.3.2 Management of Traffic Flow Near Terminals

En Route Metering organizes the flow of en route traffic bound for terminal areas. In the current system, metering is performed manually. Metering position personnel (or controllers) manually calculate estimated times of arrival and manually determine means of improving the spacing and sequencing of aircraft to the terminal feeder fixes in a fuel-conservative manner. In the Near Term, it is expected that an automated En Route Metering function will be implemented. This function would help plan the delivery of arrival flights to the feeder fixes so that the aircraft would be prepared to arrive at the runways in the proper sequence and with proper separation from other arriving and departing aircraft. The function would provide the following features to as large an extent as possible without compromising safety:

- maximum use of the runway(s) (capacity),
- conservation of fuel,
- equitable distribution of ATC caused delays (including previous delays in the air and on the ground) among the various flights,
- maximum use of those altitudes and maneuvers that are preferred by the owners and pilots of aircraft, and
- minimum discomfort of passengers (few maneuvers, low climb and descent rates).

In the Near Term, current FAA plans call for En Route Metering automation to be implemented in two phases:

- Phase 1, Landing Time Calculations, and
- Phase 2, Automated En Route Metering.

The two phases differ in the extent and sophistication of the planning and of the advisory information that they would provide. Phase 1 would provide basic, real-time information (arrival times, etc.) for arriving aircraft. The information would help metering personnel plan the delays, holds, and speed corrections needed to achieve proper flow and separation.

Phase 2 would automate the planning itself and would present detailed advisory information for each aircraft. Phase 2 would make use of Profile Descent Paths and would include multiple runways. It would organize the flow so as to minimize congestion, delays, fuel consumption, and noise in and around the terminal areas.

Inputs that would be required for Phase 2 are:

- flight information for each en route aircraft that would make use of a runway

    - position information (current and future). Obtained from the CCC's Automatic Tracking program and Flight Plan Position Processing program.

    - aircraft type, aircraft data (including takeoff weight or estimated aircraft weight in Arrival Sector). Obtained from the Flight Plan stored in the CCC.

- previous ATC delays incurred by each aircraft. Obtained from other sectors or ARTCCs and stored in the CCC.

- flight information for each terminal aircraft (VFR (Visual Flight Rules), Tower En Route, or Departure) or runway slot reservations. Obtained from each terminal (digital or voice data from TRACON).

- current acceptance rate for each runway of each airport in the terminal area. Obtained from each terminal (digital or voice data from TRACON).

- preference as to routes to be traveled in approaching the terminal.
    - Profile Descent Paths, Preferred Arrival Routes, etc. Obtained from the CCC's Adaptation data base.
    - paths predicted to be free of future conflicts. Obtained from the Flight Plan Conflict Probe function in the CCC.

Outputs that would be provided are:

- sequenced arrival lists with indicated holds, delays, etc. Provided on the metering position display.

- specific advisories as to actions that should be taken in regard to specific aircraft (e.g., decrease speed to 325 knots). Provided on radar controllers' displays.

In the Far Term, En Route Metering would be integrated with Flight Plan Conflict Probe so as to provide conflict-free metering instructions. An automated interface would be provided between En Route Metering and Terminal Metering and Spacing (M&S) so as to allow the exchange of metering data including such real-time information as runway acceptance rates, runway slot usage, or flight data for specific terminal flights. En Route Metering would also incorporate analytical capabilities for the selection of the most fuel-conservative manner of absorbing delays involving one or more aircraft. Profile descents, speed changes, path stretching, and holding patterns would be among the possibilities considered by the function.

2.3.3 Planning of Conflict-Free Paths

Currently, controllers attempt to plan conflict-free paths through a sector or sectors by manually examining the Calculated Times of Arrival at selected fixes or sector boundaries for the various aircraft that will be in a sector or sectors. It is expected that Flight Plan Conflict Probe will be implemented in the Near Term. It would provide controllers with warnings many minutes in advance of potential violation of separation standards by aircraft and would provide automated means by which controllers could test tentative methods of resolving these future potential conflicts.

A probe would automatically be initiated for an aircraft when a handoff would be accepted, when the flight's CTAs (Calculated Time of Arrival) would be changed, or when a message is entered and accepted that causes applicable changes in the Flight Plan. Probes could also be manually requested.

Initiation of a probe would cause the CCC to examine the path that the aircraft should follow according to its flight plan. The path would usually be followed only through a single sector although it could be followed through two or more sectors when advance planning information is desired. The CCC would compare the subject aircraft's path with the paths of other aircraft that would be scheduled to be in the sector (or sectors) at the same time. The paths of these latter aircraft would have been previously probed through the use of those aircrafts' flight plans.

For the new probe, the various successive positions (in both the vertical and horizontal planes) and the times at those positions would be compared to similar information that would be stored for the other previously processed aircraft. Each position for the new aircraft would be compared to the other aircraft positions for the same time, taking into account possible lateral and longitudinal errors. If a potential conflict were found, a conflict message would be displayed to the appropriate controller on his CRD.

Using the results of the probe, the controller could, if necessary, modify the flight plan of the new aircraft on a trial basis. This would automatically initiate a new probe to determine if the potential conflict(s) had thus been eliminated. When a satisfactory modification of the flight plan had been found, the controller could have this trial amendment made permanent. At that time, the stored flight plan would be updated, and revised flight strips would be printed if necessary.

The automated capability would be implemented in the Near Term. Inputs that would be required in order to perform the function are:

- flight plans for each aircraft for which a probe is to be performed. Obtained from the CCC's data base; could be tentatively altered through controller's keyboard entries.

- geographical data concerning the area that would be probed. Obtained from the CCC's Adaptation data base.

Outputs provided by the function would be:

- advisories that indicate the identities of aircraft that might be in future conflict, the time and location of the situation, the altitude overlap and the vertical behavior (ascending, decending. level) of each aircraft at that time.

In the Far Term, Flight Plan Conflict Probe would be integrated with En Route Metering so that En Route Metering would be able to provide conflict-free metering instructions.

2.3.4 Determination of Immediate Potential Aircraft Conflicts

Currently, through Conflict Alert, controllers are provided with warnings of immediate potential conflicts between tracked aircraft. When Conflict Alert coverage is in operation down to the floor of surveillance coverage, a significant number of false alerts may occur -- particularly at low altitudes near terminals. Improvements in Conflict Alert are expected to provide: (1) automatic detection of potential conflicts between a normally tracked aircraft and a Mode C equipped VFR intruder aircraft, (2) fewer false alerts even when Conflict Alert is extended to the floor of surveillance coverage, and (3) conflict protection of holding airspace from aircraft outside the holding airspace.

Changes in Message Entry and Checking, Multiple Radar Data Processing, and Automatic Tracking would cause better information to be provided to the Conflict Alert function. Many of the improvements in information would be in regard to altitudes: interim altitudes, reasonableness of Mode C replies, and altitude tracking. The Conflict Alert logic would be altered to make use of the improved information from the other functions. The Conflict Alert function, and the inputs and outputs for that function, are contained within the CCC. Alerts are currently displayed to appropriate controllers.

Current plans do not provide for any specific improvements in Conflict Alert in the Far Term. However, related improvements are expected to be made through systems that would not be contained within ARTCC buildings. Specifically, BCAS (Beacon-based Collision Avoidance System) and ATARS (Automated Traffic Advisory and Resolution Service) are planned for implementation in the Far Term.

BCAS would serve as a backup to the Conflict Alert capability provided by ARTCCs. It is anticipated that BCAS avionics would be installed in most air carrier and high performance general aviation aircraft. BCAS concepts are still evolving, so the descriptive information contained in these paragraphs should be considered to be tentative.

BCAS is an airborne collision avoidance system that would function through replies that it would receive from DABS and ATCRBS (Air Traffic Control Radar Beacon System) transponders on other aircraft. It would use these inputs to calculate range, relative altitude, and closing rate information in relation to the other aircraft that are possible collision

threats. When the projected time to collision is about 30 seconds, BCAS would indicate recommended avoidance maneuvers on a display in the cockpit of the BCAS-equipped aircraft.

A full capability BCAS is being designed to make use of interrogations from the ground as well as from the BCAS-equipped aircraft itself. However, in order to meet immediate needs, an Active BCAS is being developed for implementation early in the Far Term. Active BCAS would obtain its data by interrogating the transponders that are within range (approximately 20 miles). Such interrogations might interfere with the interrogations generated by ground-based ATC surveillance facilities. Aircraft with Active BCAS would therefore have to turn off this equipment when they are near major terminals or are in other high activity areas.

According to current concepts, Full BCAS would have three modes of operation -- with the choice of mode dependent upon the degree of surveillance coverage that is available in the area in which the aircraft is operating. The three-modes philosophy was developed to minimize the generation of interrogations by the BCAS-equipped aircraft, and therefore minimize potential interference with the normal operation of ATC surveillance.

In its active mode, Full BCAS would function in the same manner as Active BCAS. That is, it would interrogate the transponders that are within range (approximately 20 miles). In its passive mode, Full BCAS would not interrogate other aircraft. It would monitor the interrogations from ground-based ATCRBS and DABS sites and monitor the replies from the transponders on other aircraft. The hybrid mode would combine features of the active and passive modes. It would be used when the

passive mode could not be operated satisfactorily, but full use of the active mode is not required. According to one design concept, this would occur when aircraft in the vicinity of the Full BCAS-equipped aircraft are being interrogated by only one beacon ground site. (Two or more beacon ground interrogators would be required for satisfactory operation of Full BCAS in the passive mode).

In the hybrid mode, Full BCAS would monitor the replies that it receives from the single ground interrogator and determine which aircraft might prove to be collision threats. Full BCAS would then interrogate these threat aircraft to obtain more information.

Full BCAS would automatically adjust its mode (active, passive, or hybrid) of operation to its environment. It would switch modes according to a priority scheme in which passive is preferred over hybrid, and hybrid is preferred over active. In any of its modes, Full BCAS would be able to calculate range, relative altitude, and closing rate from information from other beacon-equipped aircraft. In its passive mode, it would be able to obtain bearing and bearing rate information. In any of its modes, Full BCAS would be able to detect potential conflicts and prepare avoidance maneuvers when the projected time to collision is about 30 seconds. These maneuvers would be shown to the pilot on a BCAS display in the cockpit.

ATARS is a collision avoidance capability that would be part of DABS sites in terminal and en route areas. ATARS would have its own processor which it would use to track target data obtained from DABS and to check all pairs of aircraft for closeness to one another and for danger of collision. When

appropriate, ATARS would prepare warning messages and recommended maneuvers and would have them uplinked to the aircraft through DABS Data Link. The information would be displayed to the pilot on an ATARS display in the cockpit. This information would also be sent to TRACONs and ARTCCs for display at appropriate sector positions. ATARS concepts are still evolving, so the descriptive information contained in these paragraphs should be considered to be tentative.

It is expected that each DABS site will track all aircraft operating with beacon Mode C equipment in the DABS area. This would be done independently of the en route and terminal computer systems through the use of the radar (beacon and search) and computer that would be installed at each DABS site. ATARS would have its own processor which it would use to track target data obtained from DABS and to check all pairs of aircraft to see if they are close to one another or are in danger of colliding. When appropriate, ATARS would prepare warning and command messages and have the DABS computer uplink the messages to DABS-equipped aircraft. The information would be displayed to the pilot on the ATARS display in the cockpit. It would warn him of danger or instruct him to take specific actions in order to avoid collision.

The DABS computer would <u>not</u> (and could not) send warning and command information to ATCRBS-equipped aircraft. It would, however, send to the en route and terminal computers, information on all aircraft pairs that are in conflict. The computers would discard the information concerned with those pairs in which neither aircraft is tracked.

If there is a danger that an IFR aircraft would collide with a VFR or IFR aircraft, the en route and/or terminal computers would provide controllers with appropriate information on their PVDs. The first warning to a controller would be a Controller Alert that would cause the data blocks of the subject flights to blink and would generate an entry in a Conflict Alert List that would show the Aircraft Identifications of the flights that are in conflict. If the conflict were resolved by the controller and/or pilot(s), the data blocks would stop blinking, and the entry would be removed from the Conflict Alert List. If, however, the conflict were not resolved after the Controller Alert, and conditions worsen, ATARS maneuvering recommendations would be issued for the conflict pair. The data blocks would continue to blink and would also show the recommended maneuvers that have been issued, would show any indication of compliance or non-compliance on the part of each aircraft, and in the case of an aircraft that is not equipped with an ATARS display, would indicate the need for the controller to voice (via radio) the recommended maneuvers to the aircraft. Similar information would simultaneously be shown in the Conflict Alert List and the Voice Communication Sub-list on the PVD.

In addition to helping avoid collisions between aircraft, ATARS may be able to provide other services to the aviation community at small additional cost. It appears that ATARS might be able to provide:

- Terrain Avoidance (hills, valleys, sloping land),
- Obstacle Avoidance (TV towers, microwave relay towers, radio towers, tall buildings), and

* Avoidance of Special Airspace (Terminal Control Areas, Restricted Airspace, Prohibited Airspace).

Preliminary investigations of these functions have been made. More extensive work would be required before decisions could be made as to their possible implementation.

2.3.5 Resolution of Immediate Potential Aircraft Conflicts

Currently, controllers determine their own solutions to conflict situations. No Near Term improvements are included in the current plans. It is expected that the Conflict Resolution Advisory function will be available in the Far Term to aid controllers in resolving many of the aircraft conflicts predicted by the Conflict Alert function. The Conflict Resolution Advisory function would provide resolution advisory services only to those potential conflicts that have reached an advanced state. The criteria for determining the existence of such an advanced state would be capable of adjustment.

All of the inputs to the Conflict Resolution Advisory function would come from information in the ARTCC's data base. Aircraft positional information would come from the Automatic Tracking function. Indications of potential conflicts would come from the Conflict Alert function. Resolution advisories, the outputs of the Conflict Resolution function, would be displayed to appropriate controllers.

Two functions, BCAS and ATARS, are related to the Conflict Resolution Advisory function and are expected to be available in the Far Term. Both would provide recommended solutions to conflict situations. They were previously described under 2.3.4, "Determination of Immediate Potential Aircraft Conflicts."

2.3.6 Entry and Display of Controllers' Flight Data

In the current system, controllers must handle flight progress strips and must use somewhat difficult means of entering messages into the computer. No specific improvements in this area are contained in the current plans for the Near Term. ETABS (Electronic Tabular Display Subsystem) is expected to be implemented in the Far Term.

The primary purpose of ETABS is to improve controller productivity to the point that "A" Controllers would not be needed at most sectors. ETABS would replace the Flight Strip Printers, the Computer Entry Devices at "A" and "D" positions, and the Computer Readout Devices at "A" and "D" positions within ARTCCs. ETABS would eliminate flight progress strips, improve controllers' entry of flight data, allow greater control of the display of flight data, provide better formatting of displayed data, and provide more timely information (flight data and other) to controllers. It would also provide substantial automated support to sector operations when the CCC is not operational. The support would allow controllers to update displayed flight data, perform handoff actions, and request (and receive) flight plan readouts. Such controller actions could be forwarded to the CCC when it resumes operations. ETABS would also update flight data and would route information among sectors when the CCC is not operational.

All of the inputs to ETABS would come from within the ARTCC:

- **flight plans, flight data, other data. Entered by controllers and/or obtained from the CCC through the Data Entry and Display Subsystem.**

All of the outputs from ETABS would go to equipment within the ARTCC:

- displayed, sequenced flight data entries. Used by "D" Controllers.

- displayed menus of potential messages (e.g.: Departure, Hold, Cancellation) and message components (e.g.: altitudes, fixes). Used by "D" Controllers to enter messages.

- up-to-date flight data. To be provided to the CCC if needed after CCC has been down.

2.3.7 Backup Surveillance Display Capability

DARC will provide radar controllers with a backup capability when the normal radar display capability is not available. Because of the need for 24-hour-a-day operation of ARTCCs, DARC will also be used to free the CCC and/or the Data Entry and Display Subsystem or portions thereof, for maintenance work.

DARC will be implemented in the Near Term. DARC equipment is in production, and the first system is expected to be in operation within the first half of Calendar Year 1979. The DARC system at each ARTCC will consist of a Radar Multiplexer Subsystem, Display Processor Subsystem, Control Processor Subsystem, and a System Status and Control Subsystem. The inputs to DARC will come from En Route Surveillance sites, the CCC, and Radar Console Controls:

- beacon codes, aircraft identification, assigned altitudes. Obtained from the CCC.

- target returns and replies. Obtained from the surveillance sites.

- assigned altitude changes, beacon code changes, controller-entered reported altitudes. Obtained from Radar Console Controls through keyboard entry.

Outputs from DARC:

- aircraft targets, weather, data blocks, map data. Displayed on PVDs at "R" Controller Positions.

The capability of displaying broadband surveillance information is available in the current system. As DARC is implemented and accepted in the Near Term the broadband capability will be removed from ARTCCs.

Current plans do not call for specific changes in Backup Surveillance Display Capability in the Far Term; however, various changes are under consideration. See "Additional Potential Improvements" in 2.1 for further information.

2.3.8 Communication with Aircraft

No improvements in this area are planned for the Near Term. In the Far Term, Data Link (DABS) is expected to be implemented and available to provide rapid non-voice communication between the ARTCC and aircraft. As yet, specific plans or decisions have not been made in regard to its use for communication between ARTCCs and aircraft. The en route applications that are currently the most favored candidates for initial implementation are: ATARS, altitude assignment confirmation,

MSAW advisories, hazardous weather advisories, and routine weather data on request. En route applications favored for later implementation are: metering commands, route-oriented weather, status of Category II/III precision approach protected areas, frequency assignment, heading/speed instructions, holding instructions, airborne situation display, and downlinked weather.

2.3.9 Input, Output, and Display Processing

In the current system, Input, Output, and Display Processing are performed in an ARTCC by the CCC and the Data Entry and Display Subsystem. ARTCC sector control positions and TRACONs/TRACABs are heavily dependent upon these functions on a minute-by-minute basis.

In the Near Term, a backup capability will be provided to ARTCC sector control positions through the implementation of DARC. This improvement has previously been described.

In the Far Term, further backup capability for ARTCC sector control positions would be provided through ETABS (previously described). Some of the TRACON/TRACAB minute-by-minute dependence on the host ARTCC would be eliminated by the implementation of TIPS (Terminal Information Processing System).

TIPS would decrease the TRACON/TRACAB near-time dependence on ARTCCs, in that the delivery of flight plans to TRACONs/TRACABs would not be time-critical, and flight progress strips would not be prepared for TRACONs/TRACABs. In the present system, TRACONs/TRACABs regularly receive flight progress strips (FDEP) and flight plans (ARTS III or ARTS II) from their

host ARTCCs. Since ARTS computers can store only a few flight plans at a time, they are only sent flight plans for those aircraft that are to arrive or depart within the next few minutes. During an ARTCC or communications failure (ARTCC to TRACON), a TRACON would receive no further flight plans and in a short time would not have up-to-date flight data available. In the Far Term, with TIPS available, such momentary outages would have less effect on TRACON/TRACAB operations, since it is expected that TIPS would store the available flight data for up to two hours in advance of the scheduled arrivals or departures. Such advance flight data would also be used for long-range flow planning within the terminal airspace. TIPS would also provide TRACON/TRACAB controllers with flight data entry displays instead of the flight progress strips formerly provided by the ARTCCs.

In the Near Term, Dual Common Digitizers (CD-2s) are expected to be available at surveillance sites. In addition to improving reliability through redundancy, they would provide improved weather data for display on PVDs. Improved display of ARTCC weather would also be available through three-dimensional digitized weather data that is expected to be obtained from NWS Weather Radars in the Near Term. Digitized turbulent weather (instead of precipitation) data would be obtained from Joint Use En Route Weather Radar Sites and/ or ARSR Weather Channels in the Far Term. It is expected that the ARTCC display would not make full use of the three-dimensional capabilities and multiple contour capabilities (eight levels of weather intensity) until the Far Term.

2.3.10 Radar Data Processing and Automatic Tracking

These functions currently provide processed surveillance data to controllers and to other ARTCC automation functions.

In the Near Term, DARC will be implemented. It will provide a backup capability for the CCC. Although DARC does not mosaic radar data from multiple sites and does not perform automatic tracking, it will provide substantial information to controllers when the CCC is unavailable. The capability is more fully described under "Backup Surveillance Display Capability." Enhancements to Automatic Tracking are also expected to be implemented in the Near Term. These would include greater accuracy and reliability in altitude tracking and improved reasonableness testing of altitude information. The incorporation of these improvements should reduce the number of false conflict alerts at low altitudes.

In the Far Term, DABS is expected to be implemented. For the CCC, it would provide more accurate radar and beacon data.

2.3.11 Real-Time Management of Traffic Load

These functions are generally performed by Local Flow Control personnel in ARTCCs. Currently, Local Flow Controllers perform their duties with virtually no automation aid. They manually monitor severe weather in the ARTCC area, unusually large gatherings of people for special events (e.g., sports, political groups, business conventions), and other occurrences that may result in marked increases or decreases in traffic flow in particular areas. They manually inspect sector positions to detect the buildup of overload conditions for specific sectors. They change the flow of traffic when warranted, change sectorization, attempt to equitably distribute ATC-caused delays, and arrange for additional controllers to be available to handle heavy predicted loads.

No specific direct improvements in Local Flow Control are currently planned for either the Near Term or Far Term. However, indirect improvements are expected to be available through En Route Metering and Flight Plan Conflict Probe. En Route Metering would simplify local flow controllers' work because of its organization and smoothing of traffic flow to terminal areas. Through the use of Flight Plan Conflict Probe, local flow controllers would be able to detect future overloading of sectors and would be able to test tentative rerouting of aircraft.

2.3.12 Computer Systems' Capacity and Reliability

The possible replacement or augmentation of en route computer equipment and software is being considered because of the increased needs that are anticipated in regard to computer capacity, reliability, and maintainability. In the Near Term, it is expected that some additional Computing Element capacity will be made available through the transfer of a portion of Computing Element load to the under-loaded IOCEs (Input Output Control Elements) in each ARTCC.

There is general agreement among FAA management personnel that improvements in this area are required, and various investigations and studies are now underway. Additional computer capacity will be required as a result of increased demand due to increased traffic load and to functions being added to the system in the Near Term and Far Term. Most of the internal ARTCC improvements would require additional data processing and storage. Most of the external improvements related to ARTCCs would also require additional data processing and storage because these improvements generally result in more and different data being transferred to and from ARTCCS.

The needed increases in capacity can be obtained through the recovery of existing capacity and/or through the incorporation of additional hardware.

Productivity improvements are expected to offset the effects of increases in traffic load, thus allowing ATC to be performed without adding more control personnel. This will result in a smaller number of trained control specialists per controlled aircraft. With such a small ratio of specialists to aircraft, it will be very difficult to exercise manual control in the event of an automation failure. Thus, automation failures should be minimized by making the computer systems (including software) as reliable as possible.

The current computer equipments may be increasingly difficult to maintain in the future, and parts may be difficult to obtain. The principal computer equipments in ARTCCs are 9020s (IBM-360s) and Raytheon 730s. IBM 9020As and 9020Ds are used as CCCs, and 9020Es are used as Display Channel processors. Most ARTCCs use Raytheon CDCs (Raytheon 730) as Display Channel processors. IBM-360s and Raytheon 730s are old, large, slow, and inefficient compared to present day state-of-the-art computers.

The need for increased computer capacity, reliability, and maintainability may appear obvious; the best course of action to be taken to achieve this additional capability is not obvious. Replacement would require a substantial investment in hardware and software. The present equipment functions well, and could be augmented with state-of-the-art computers to perform some of the additional functions (such as Conflict Resolution and Flight Plan Conflict Probe) that are planned

for the future. The subject of replacing or augmenting ARTCC computing equipment and software is currently under study, but no decisions have been made.

2.3.13 Flight Data Processing

Currently, Flight Data Processing is performed automatically in the CCC. This function collects and processes Flight Plans and related data so as to provide information to controllers and to other processing functions (e.g., Flight Plan Aided Tracking, Conflict Alert). Processed flight data information is printed on flight progress strips, displayed on Computer Readout Devices, and sent to adjacent facilities (ARTCCs, TRACONs, etc.). Flight Data Processing includes:

- the acceptance and processing of flight data entered from within the ARTCC and from remote locations
- the storage and processing of pre-filed flight plans, and making such flight data available at the correct chronological time
- the preparation of fix time calculations
- the storing and readout upon request of selected weather observations, altimeter settings, etc.

Flight data processing includes the highly complex checking and conversion of filed routes of flight that are contained within flight plans. It must process many varieties of routes (from random direct routes to highly structured, pre-stored routes) to provide check points and calculated times of arrival for use by controllers and by other software functions.

Current plans do not provide for any specific changes in the automated Flight Data Processing function for the Near Term or Far Term.

2.3.14 Aviation Weather Collection and Dissemination

Currently, collection and dissemination of aviation weather is not an integrated function within an ARTCC. Most ARTCCs have only a single meteorologist and do not have a position at which the various weather equipment is consolidated.

In the Near Term, Center Weather Service Units (CWSU) will be located in all ARTCCs. The CWSUs will be the major focal points for real-time collection, monitoring, interpretation, and dissemination of hazardous weather information. Professional meteorologists will man each CWSU. They will monitor weather developments and provide general weather briefings and hazardous weather advisory services to controllers. One of their major duties will be the collection, interpretation, and dissemination of PIREPs. Each CWSU will have:

- a PVD with a capability of selectivity viewing all sectors within the ARTCC
- two WBRRs (Weather Bureau Remote Radar recorders) that will receive their data from NWS WSR-57 radars
- an Alden Facsimile machine for receiving weather maps
- a GOES (Geostationary Operational Environmental Satellite) satellite photo recorder that receives its information from the ATCSCC

- a Service A teletypewriter drop for requesting and receiving weather information from the WMSC

- telephone and interphone service.

In the Far Term, the CWSU would have an NWS AFOS (Automation of Field Operations and Services) data processing, communications, and display system with direct interfaces to the NWS National Distribution Circuit, to NADIN, and to the ARTCC's CCC. Also in the Far Term, the WBRRs would receive three dimensional weather data from Joint Use Weather Radar Sites, and the Service A teletypewriter would be replaced with higher speed communication through NADIN.

2.3.15 System Maintenance and Monitoring

Currently, much of the monitoring of system performance, monitoring of equipment status, routine maintenance, and equipment certification is performed by maintenance personnel through hands-on examination of the equipment and software. Within an ARTCC area, most of the equipment is within the ARTCC building, but some is at remote sites. The System Maintenance Monitoring Console (SMMC) in the ARTCC provides a centralized monitoring and control position for the ARTCC's Systems Engineers. For the equipment within the ARTCC building, extensive status information is automatically sent to the SMMC on a regular schedule. For remotely located equipment, much less information is automatically made available to the SMMC, and therefore, periodic visits of maintenance personnel to the remote sites are required in order to perform most maintenance and certification functions. (For en route surveillance sites, status messages are periodically sent to the SMMC. For Navigation Aids and RCAGs (Remote Communications Air/Ground), information must

be entered manually at the SMMC after it is received by voice telephone.)

In order to maximize personnel resource utilization and improve system availability by trend analysis and failure prediction, the FAA is pursuing the obtaining of a Remote Maintenance Monitor System (RMMS) for some of its remote facilities. According to current concepts, this system would provide a remote maintenance monitoring capability for three major types of facilities: Remote Communications Air/Ground (RCAG) facilities, navigation (VORTAC) facilities, and En Route Surveillance Radars (ARSRs). The equipment monitored in the latter facilities would include search and beacon radars and the common digitizer. Maintenance monitoring information would be remoted from these facilities to a central processor at the ARTCC where all information would be stored in a central data base. Maintenance men would be provided with terminals through which they could address the central processor to obtain current status and historical information concerning the performance of various equipment. Similar capabilities are expected for TRACONs and Towers under a separate program; however, the relationship between this program and the RMMS is not well defined at the present.

The basic capabilities being addressed by the RMMS program at the present time are: monitoring equipments and alarms, remote certification, automated recordkeeping, trend analysis, and remote control of power sources. Monitored parameters would be continuously scanned and compared against stored standards. Certification would be provided remotely if the parameters were found to be within a specified acceptable range. Facility logs and facility performance reports would

be kept automatically by the central processor, and outages would be automatically reported. The trend analysis would provide an early detection of weak links and a long term evaluation of Mean Time Between Failures (MTBF) and Mean Time Between Repairs (MTBR). The remote control capability might be limited to generator activation/deactivation.

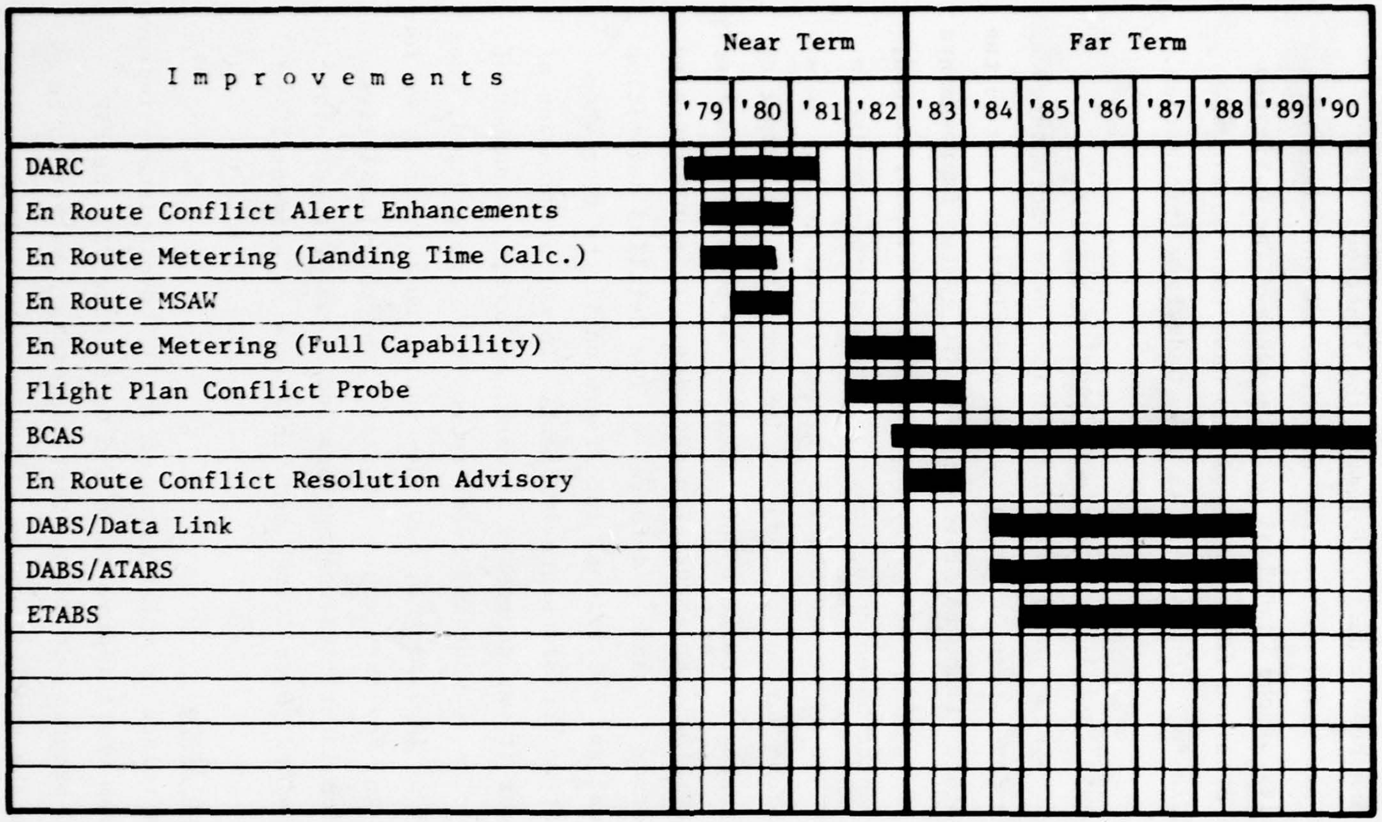
It is anticipated that the RCAG remote maintenance monitoring capability will be a Near Term improvement. It would be followed in the Far Term by implementation of RMMS for the en route surveillance radars and for the navigation facilities. Since this document concentrates on those functions directly related to the providing of ATC services, RMMS and other maintenance functions are not shown in the connectivity diagrams (Figures 2-1, 2-2, and 2-3).

Potential improvements in this field include remote diagnostics, isolation of failing equipment, and remote adjustment of equipment. They also include failure anticipation and scheduling of corrective action prior to malfunction. Computer files of equipment problems and solutions may also be incorporated.

2.4 En Route Facilities Tentative Implementation Schedule

Figure 2-7 shows the tentative implementation schedule for the principal improvements to the En Route Facilities, BCAS, DABS, and ATARS. The latter three are included since they are closely related to many ARTCC functions.

Generally, the schedules for implementation are not schedules that have been approved by FAA management. In most cases, no



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 2-7
EN ROUTE FACILITIES - ARTCC
TENTATIVE IMPLEMENTATION SCHEDULE

decision has been made to implement the function. The schedules are based on the best estimates of the times of availability of the Technical Data Packages. The estimates have been obtained from personnel who have been working on the specific function as well as from budgetary information.

2.5 En Route Facilities Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in the various options for implementing the output of the E&D program to be kept open until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in an en route facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "Open Items" and "Interface Adjustments."

2.5.1 Open Items

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, an Open Item involves more than one F&E and/or E&D

program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the en route facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for en route facilities. Instead, they might be contained within the program of another interfacing facility. The Open Items pertinent to En Route facilities are:

Open Item 1: Interface/Integration of Automated Air Traffic Functions

1. Central Flow Control predictions of en route delay would continue to be improved through enhancements in delay forecasting and more data inputs from the en route and terminal ATC facilities, but Central Flow Control (CFC) would not have any automated interface with En Route Metering or ARTS III M&S. The use of Fuel Advisory Departures would be refined to reflect the improved CFC predictions.

2. Initial versions of Flight Plan Conflict Probe (FPCP) and En Route Metering would be developed as independent functions. Later versions would be integrated so that the En Route Metering advisories would provide for conflict-free metering instructions. En Route Metering would also be developed to consider efficient ways of absorbing delay

to conserve fuel. This will include profile descents, speed changes, path stretching, and holding patterns.

3. The function of Local Flow Control and the concept of providing information specifically tailored for the Local Flow Controller will not be improved upon over and above the improvements that will be associated with en route metering and FPCP.

4. The implementable version of ARTS III Metering and Spacing (M&S) will include flexible control algorithms that will permit profile descents with little or no vectoring during low demand periods and will utilize tighter control procedures with potentially more vectoring during high demand periods. The tighter procedures are invoked to improve the interarrival spacing at the threshold and thus maintain high runway capacity during high demand periods.

5. An interface will be developed between M&S and terminal area Conflict Alert to provide conflict-free M&S commands.

6. An automated interface will be developed to maximize efficiency of operations between En Route Metering and ARTS III M&S.

Open Item 2: Evolution of DABS Capability

1. The DABS capability will be realized by a direct replacement of ATCRBS sensors with DABS sensors rather than by first upgrading ATCRBS sensors to include a monopulse

detection and processing capability and then, at a later date, upgrading those sensors to the DABS configuration.

2. The DABS sensors installed for en route surveillance will include back-to-back antennas to increase the data rate. This assumption follows from a related assumption that ATARS will be implemented at the en route DABS sensors.

3. DABS sensors for improved surveillance and data link capability will be implemented at the earliest reasonable date. A corollary assumption is that the complete DABS sensors will be implemented sufficiently soon as to preclude the need for earlier installations of just the DABS data link capability at locations where the full DABS capability will eventually be deployed.

4. Initial DABS/ATARS implementation will be based on single site/collision avoidance capability. DABS surveillance information will be combined at the associated control facilities. Subsequent to the initial implementaion, provisions will be made for exchanging data between selected DABS/ATARS sites to improve their collective collision avoidance capability. Several options are being explored to provide for the exchange of information. One of these options, the coordination through the associated ATC facility, was assumed in this document.

5. Initially, DABS implementation at terminals will be restricted to those sites having ARTS III automation.

Open Item 3: Time Phasing of DABS vs Plans to Use DABS Data Link and Other DABS-Dependent Items

It was implicitly assumed that the FAA will develop a plan for using the DABS data link capability on a schedule that is consistent with the DABS implementation schedule and that the benefits, as perceived by user groups, would result in installation and use of associated avionics.

Open Item 4: Aircraft Separation Assurance

1. The assumption was made that all of the programs aimed at providing automated aids to the pilot and the controller for the avoidance of midair collisions will be successful and will be implemented. These programs include:

a. En Route Conflict Alert

b. En Route Conflict Resolution advisory function

c. Terminal Conflict Alert (ARTS III sites)

d. Terminal Conflict Resolution advisory function (ARTS III sites)

e. ATARS (at all DABS sites)

f. BCAS -- "active only" for initial implementation but followed by more sophisticated systems later.

2. It was further assumed that the technical designs of each of the capabilities listed above will be realized within an overall design of an airborne separation assurance system which will assure proper interoperability among the various features and avoid presenting either the pilot or the controller with conflicting instructions or advisories.

Open Item 5: En Route Radars

1. It was assumed that no major changes would be made to improve either aircraft detection or weather detection in the en route airspace in the Near Term system (prior to 1983).

2. ARSRs (including the new ARSR-3s) will be modified to improve both their weather detection and aircraft detection capabilities in the Far Term. Aircraft detection will be improved through the addition of MTD. Weather detection will be improved through the addition of a separate ARSR weather channel.

3. As a further step in the improvement in the detection of weather, particularly turbulent weather, the FAA will join with the National Weather Service (NWS), and the Air Force Weather Service (AWS) in the development of a new three-dimensional (3D) weather detection radar. That new 3D radar will be implemented throughout the conterminous U.S. to provide coverage of airspace of interest to the ARTCCs.

4. New ARSR-4s will be procured to replace older tube type radars to reduce maintenance costs and improve reliability. The new ARSR-4s will include both an MTD type capability for aircraft detection and a separate weather channel. (This implies that the FAA intends to continue to maintain and operate primary radars for en route surveillance for the foreseeable future.)

5. For the Far Term, it was assumed that the en route weather detection capability would be provided by both

the ARSRs (ARSR-4 and the modified ARSRs) and the Joint Use 3D Weather Radar.

Open Item 7: Surveillance Data Preprocessors

1. CD-2s will be procured and implemented for the preprocessing of ARSR and ATCRBS en route surveillance data. In the Far Term, these CD-2s will be modified twice: first to accommodate the MTD and later to accommodate an ARSR weather channel. Within a few years, the CDs will be replaced by DABS Processors (July 1984).

2. SRAPs (sometimes referred to as SRAP I) will be procured and implemented for the preprocessing of ASR and ATCRBS terminal area surveillance data. The SRAPs will be located at the ARTS III TRACON facilities. Those same SRAPs will go through two modification programs. The first modification will be to accommodate the addition of MTD to the ASRs. The second modification would come about six months later to accommodate the separate ASR weather channel. Six months later, the modified SRAPs would be replaced by the DABS processors.

Open Item 8: VAS/WVAS Interface/Interaction with ARTS III Metering and Spacing and En Route Metering

1. A manual interface will be established between ARTS M&S, the Vortex Advisory System (VAS) and en route metering that will permit the use of reduced longitudinal separations when the VAS indicates that wake vortex conditions are favorable.

2. As the VAS evolves to a more capable Wake Vortex Avoidance System (WVAS) an automated interface will be

implemented between the cited system elements to allow the benefits of further reductions in longitudinal spacing (possibly tailored on an aircraft pair basis) to be operationally realized.

Open Item 9: Replacement/Augmentation of NAS 9020 Central Computer Complexes

The NAS 9020 Central Computer Complexes will be the primary computer capability at ARTCCs through the 1980s. The 9020s will be augmented as needed to accommodate forecasted increases in air traffic and the full spectrum of planned ATC improvements. These improvements include En Route Metering, Flight Plan Conflict Probe, En Route MSAW, Conflict Alert Enhancements, Conflict Resolution, Direct Access Radar Channel, Electronic Tabular Display Subsystem, Digitized Weather Data, DABS Data Link, and ATARS.

Open Item 11: DARC/ETABS/CCC Interface

The Direct Access Radar Channel (DARC) and Electronic Tabular Display Subsystem (ETABS) will have the ability to exchange data that is sufficient to permit effective stand-alone operation in the event that either the ARTCC's Central Computer Complex (CCC) and/or the Data Entry and Display Subsystem (DEDS) is not available.

Open Item 15: Voice Communications Planning

1. Air-ground-air communication for the ARTCCs and major terminals will be upgraded in the post-1982 time period by implementation of the radio portion of VSCS, which would be referred to as RCCS. In the Near Term, RCAG tone control equipment for the ARTCCs will be replaced, possibly

with a modular subsystem that would be compatible with longer term RCCS/VSCS designs. The FSSs, which are assumed to remain unconsolidated, will continue to use switching and control equipment based on existing designs. In addition, the transmitters, receivers, and antenna systems at all FAA ground sites will be replaced with modern design equipment.

2. Ground-ground communications would be modernized by the implementation of ground-ground portions of the VSCS system which would replace the WECO 300 system at ARTCCs, and the WECO 301 system at the larger terminals. The existing small key systems and call distributors at FSSs would remain in place.

3. At some smaller terminals a Small Voice Switching System (SVSS) will be implemented, which will provide an integrated radio and ground voice communications capability.

Open Item 18: Detection of Turbulence and Low Level Wind Shear

1. No major improvements will be made in the detection of hazardous weather in the Near Term ATC system configuration (i.e., no major improvements implemented prior to 1982 with the exception of the Low Level Wind Shear Alert System (LLWSAS)).

2. The first major improvement will start to be implemented in the early part of the Far Term system (1984). The first major improvement will be achieved by modifying both the ARSRs and the ASRs to include what is referred to as a separate weather channel. The separate weather channel is likely to include an MTD capability for the special processing of the returns from precipitation to indicate areas of heavy precipitation. In order to achieve this capability, all ARSRs and ASRs will be modified or replaced. In the case of both the ARSRs and the ASRs, the weather data will be two-dimensional (range and azimuth).

3. The second major improvement will be realized by adding the 3D weather detection capability, i.e., range, azimuth, and altitude of turbulence and low level wind shear. For the en route system, the 3D capability will be realized through a joint FAA/NWS/AWS program to develop and implement a Joint Use Weather Radar. For the terminal area system, the 3D capability will be realized either through a further modification to the ASRs to provide a 3D capability and/or through inputs from the Joint Use radars for those terminal areas where coverage from the Joint Use radars satisfy the terminal control requirements for detecting low level wind shear as well as turbulence.

4. The 3D weather detection system for the terminal area will include the capability of detecting and analyzing turbulence and wind shear in clear air as well as under conditions where precipitation is present.

Open Item 19: Weather Data Dissemination

A Center Weather Service Unit (CWSU) will be implemented at each ARTCC and will receive, interpret, coordinate, and dispatch graphic and tabular weather data to controller operating positions within the ARTCC and in associated TRACONs. The distribution of weather data to controller positions will be accomplished by TIPS for Towers/TRACONs and will be accomplished by ETABS for ARTCCs. In light of incomplete FAA plans for accomplishing the distribution of graphical weather data to controller positions, the specific devices used for distribution were not designated in this document.

Open Item 20: Remote Maintenance and Monitoring

1. Integrated remote maintenance and monitoring functions will be incorporated into the RCAG, en route surveillance, VORTAC and airport facilities for navigation, communications, and surveillance. The Remote Maintenance Monitor System (RMMS) capabilities consist of equipment monitoring and fault alarming, remote certification, automated record keeping, trend analysis and remote control of redundant units and some facility functions.

2. The RMMS at airport facilities would utilize a special processor to be located in the associated tower/TRACON. For other facilities, the RMMS will utilize a dedicated processor located at each ARTCC. All maintenance information will be transmitted from the cited facilities via existing communication links to the processor for storage, processing, and access by technicians using special common terminals located either local to the ARTCC or at remote

locations. No assumptions were made regarding how the RMMS data would be provided and displayed to the responsible technicians since FAA plans have yet to be made in these areas.

3. The DABS and MLS systems to be installed in the Far Term will also incorporate RMMS functions that are compatible with the above concept.

<u>Open Item 22: Evolution of the ATC System to Include Advanced En Route Automation (AERA)</u>

1. AERA will be operationally integrated into the en route ATC system after the "Far Term" configuration described in this document has been implemented. This means that AERA will be introduced into an en route system where En Route Metering, Flight Plan Conflict Probe, Conflict Alert, Conflict Resolution, and automated interfaces with terminal automation facilities have already been successfully implemented and are available as aids to the controller. (This presupposes that the current E&D programs will be successful and produce products that will be implemented.)

2. There will be a transition period when the en route data processing and display complex must be able to perform all the functions ascribed to the "Far Term Configuration" <u>plus</u> the functions to be automated by AERA.

3. After the transition period, some of the functions ascribed to the "Far Term Configuration" will be assumed by the AERA programs while other functions of the "Far Term Configuration" will be retained. For example, AERA may

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DEFINITION, DESCRIPTION, AND INTERFACES OF THE FAA'S DEVELOPMEN--ETC(U)
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provide all the assistance needed with respect to En Route Metering and Flight Plan Conflict Probe and thus eliminate the need for retaining the En Route Metering and Flight Plan Conflict Probe as initially developed for NAS Stage A in the pre-AERA period. On the other hand, the Conflict Alert and Conflict Resolution capabilities developed for NAS Stage A in the pre-AERA period may be retained in order to provide the alert/resolution signals to the controller for those hopefully infrequent occasions where controller intervention is required to avoid violation of separation standards. This is merely an illustration of some of the things which will need to be considered during the integration of AERA capabilities as a part of the overall en route control system. If such an integration takes place, there seems to be at least a reasonable chance that the total requirements for en route data processing and display may be less demanding after the transition phase then during the transition phase.

4. Sometime during the 1985-1995 time frame, the FAA will be replacing the current NAS Stage A data processing and display systems with the next generation equipment. Implementation of AERA will take place during that same time frame. The FAA will time phase the implementation of AERA with the introduction of new data processing and display systems as part of a total program that will not adversely affect system operations and will at the same time minimize the costs of implementing AERA.

2.5.2 Interface Adjustments

This section identifies some fairly specific smaller scale interface uncertainties. These uncertainties generally involve minor design modifications in one or more programs that are not considered as significant as the previously cited Open Items. The Interface Adjustments pertinent to the En Route Facilities chapter are:

Interface Adjustment B2-1 -- Exchange of Conflict Alert Information between Facilities

In the future, it may be desirable to exchange Conflict Alert and Conflict Resolution Advisory information between facilities (ARTCC and ARTCC; ARTCC and TRACON). This would be done so that both facilities could have the same conflict information for aircraft that are at, or near the boundary between the two facilities.

Interface Adjustment B2-2 -- Communication between DARC and CCC

As currently planned, DARC will be able to receive messages from the CCC, but will not be able to send messages to the CCC. Two-way communication would appear to be very advantageous.

Interface Adjustment B2-3 -- Three-Dimensional Weather Interface with En Route Facility

In the Far Term, digitized weather data will be provided to ARTCCs. The data will have altitudes associated with it, and thus will be three-dimensional. Conceptual and experimental work should be performed to make certain that the weather data will be displayed in a manner that will make it most useful to controllers.

3. TRACON FACILITIES

This chapter is concerned with TRACONs (Terminal Radar Approach Control, IFR Room) and TRACABs (Terminal Radar Approach Control Tower Cab). TRACONs are at airports at which approach control is principally performed in an IFR (Instrument Flight Rules) room. Additional approach control work is performed at one or more associated Tower Cabs at major and satellite airports. TRACABs are at airports at which approach control is performed only in the Tower Cab.

The control exercised by TRACON/TRACAB facilities is generally limited to those aircraft that are operating within the terminal area but are not within the Airport Traffic Area. The Airport Traffic Area is that area that is within five miles of an airport and is below 3000 feet AGL (Above Ground Level).

Automation Equipment

All TRACONs and TRACABs are now, or will in the future be, equipped with data processing equipment to provide automation of some Air Traffic Control functions. Three general types of automation equipment are used: ARTS (Automated Radar Terminal System) III, ARTS II, and TPX-42. ARTS III is currently operational at 63 sites. It is expected that all of these will be upgraded to ARTS IIIA sites (27 of them are currently being upgraded).

The emphasis in this chapter will be on TRACONs equipped with ARTS III equipment. Such configurations provide the highest level of terminal automation. TRACONs and TRACABs equipped with ARTS II or TPX-42 equipment provide many of the same functions as the ARTS III TRACONs but with less sophistication and flexibility.

Table 3-1 shows a comparison of the features of the various current terminal automation equipments. Table 3-2 shows the Current and Near Term deployment of automation equipment among the various terminal ATC facilities. The following paragraphs briefly describe these equipments.

ARTS III and ARTS IIIA

ARTS III and ARTS IIIA are similar in many respects. Both systems are designed and produced by UNIVAC. Many of the equipments and much of the software are common to the two. All of the basic ARTS III facilities are now operational. The first ARTS IIIA site is expected to become operational in the Spring of 1979. Both ARTS III and ARTS IIIA are programmable data processing systems that are capable of receiving information from various sources (surveillance sites, host ARTCCs, controllers' keyboard entries, etc.) and sending information to various destinations (controllers' displays, host ARTCCs, etc.). Because they are general-purpose data processing systems, they are capable of being programmed to provide many of the software functional improvements (e.g., Conflict Alert, Conflict Resolution Advisory, Terminal Metering and Spacing) that are described later in this document. Although ARTS III and ARTS IIIA have limited computing capacity and storage, it appears that all sites would have enough capability (possibly through some augmentation with special purpose computers) available to support the functional improvements that are envisioned for TRACONs. The computing and storage capacity of ARTS IIIA has been increased over that of ARTS III, but it appears that (at least for some sites) both ARTS III and ARTS IIIA will need to be augmented.

One of the key functional improvements provided by ARTS IIIA is the expansion of processing to include search radar targets in

TABLE 3-1
FEATURES OF AUTOMATION EQUIPMENTS CURRENTLY USED FOR TERMINAL AUTOMATION

	BASIC ARTS III	ARTS IIIA	ARTS II	TPX-42
Automatic Tracking of Beacon Targets	X	X		
Automatic Tracking of Search Radar Targets		X		
Displays on Plan View Displays:				
• Beacon Replies	X	X	X	X
• Search Radar Returns	X	X	X	
• Data Blocks Associated with Beacon Replies	X	X	X	X
- Various Alphanumeric Characters or Symbols Usable as Position Symbols	X	X	X	X (Limited to X and O)
- Aircraft Identification (Call Sign)	X	X	X	
- Assigned Altitude (IFR Flights)	X	X	X	
- Mode C Altitude	X	X	X	X
• Data Blocks Associated with Search Returns		X		
• Tabular Data (e.g.: Arrival/Departure List)	X	X	X	X
Automation-aided Non-verbal Handoffs	X	X	X	
Exchange of Radar Position & Track Data with Host ARTCC	X	X	X	
Exchange of Flight Data (Flight Plans, FP Changes, Departure Messages, etc.) with Host ARTCC	X	X	X	
Controller-enterable Keyboard Message	X	X	X	
Redundant Equipment & Fail-Soft Capability		X		
Multiprocessing Capability		X		

TABLE 3-2

TERMINAL ATC FACILITIES

AIRPORT TYPE		TRACON	TRACAB	TOWER CAB
High IFR Activity Airports (67)		ARTS III Automation (63)	None	67 Airports*
Medium IFR Activity Airports (112)		ARTS II (50)** TPX-42 (11)	ARTS II (23)** TPX-42 (28)	112 Airports
Low IFR Activity Airports	High VFR Activity Airports (222)	None	None	222 Airports
	Medium and Low VFR Activity Airports (10,000 +)	None	None	None

*Several of the high IFR activity airports share a common TRACON, e.g., JFK, Newark, and LaGuardia in New York City.

**Near Term deployment

addition to beacon targets. The system will track such targets and will display data blocks that identify the tracked aircraft. ARTS III reliability will be increased through the use of redundant equipment and fail-soft capability. The latter provides automatic switching of equipment (e.g., memories or Input Output Processors) so as to remove and replace improperly functioning units. Other features include: multi-processing, a separate buffer memory for each display, automatic overload sensing and protection, remote tower display and data entry, and continuous data recording that can be controlled through keyboard messages.

A special expanded ARTS IIIA system will be installed in the New York TRACON. This facility will use four radar sites, will have 30 operational displays, and will be used to control traffic in an area that is approximately 100 nautical miles by 150 nautical miles. Displays and radars will be adapted so that each display can be served by either a primary or alternative site. The ARTS IIIA for the New York TRACON will include a Communications Multiplexer Controller. This device will allow digital data communication (at 2400 baud) between the IFR room and BRITE (Bright Radar Indicator Tower Equipment) displays in five associated Tower Cabs. At J. F. Kennedy and Newark airports, there will be two BRITE displays in each Tower Cab. Each BRITE display will have input capability through its associated keyboard. Similar expanded ARTS IIIA systems may be required at other high activity terminal areas.

<u>ARTS II</u>

ARTS II -- like ARTS III and ARTS IIIA -- is a programmable data processing system. Its computing and storage capacities will be considerably less than those of either ARTS III or ARTS IIIA. ARTS II is being designed and produced by the Burroughs

Corporation. The first ARTS II site is expected to become operational early in 1979. As with ARTS III, ARTS II will have the ability to communicate with its host ARTCC, with controllers through displays and keyboards, etc. Various software enhancements (e.g., Conflict Alert, Minimum Safe Altitude Warning system, and Automatic Tracking) have been considered for ARTS II, but are not being actively developed at this point. Currently, ARTS II does not provide tracking, but does display data blocks for both discrete and nondiscrete beacon replies.

TPX-42

The TPX-42 has the least capability of the currently-used terminal automation equipment. It is not a programmable data processing system. However, various functions can be controlled through panel switches and dials. The TPX-42 was designed and produced by AIL, a Division of Cutler-Hammer. All of the TPX-42 facilities are now operational. The TPX-42 does not provide tracking or tabular information on PVDs. It does provide labels for discrete and nondiscrete beacon replies. However, the labels contain less information, cannot contain as wide a variety of information, and are not as easily changed as those of the ARTS systems. It is expected that the TPX-42s will be replaced with more sophisticated equipment some time in the future. ARTS II and a programmable version of the TPX-42 are being considered as a replacement system. A decision on replacement is expected in 1980.

Chapter Content and Organization

Except where otherwise noted, when a TRACON is referred to in the remainder of this chapter, it will denote an ARTS IIIA TRACON. It should, however, be kept in mind that many of the same functions and capabilities will be available with TRACONs and TRACABs equipped with ARTS II or TPX-42 equipment.

Although the principal ATARS and BCAS equipment are not contained within TRACON rooms, they are briefly described, since they would be used in terminal airspace and would be part of the general collision-avoidance/separation-assurance area of which the Terminal Conflict Alert and Terminal Conflict Resolution Advisory functions are parts.

The remainder of this chapter consists of the following sections:

- TRACON Facilities Improvements Summary (3.1). This section lists important functional areas and the improvements planned for these areas. For each function, there is a separate brief description of the method by which the function is currently performed, the planned improvement(s), and the manner in which the improvement(s) would enhance the performance of the function. (Further, more detailed information in regard to each improvement is contained in Section 3.3).

- TRACON Facilities System Connectivity (3.2). This section contains three connectivity diagrams -- one for each of the three system phases: Current, Near Term, and Far Term. The changes in connectivity between phases are briefly described.

- TRACON Facilities Information Flow (3.3). This section contains three Information Flow Diagrams -- one for each of the three system phases (see above). The diagrams show the facilities that provide inputs to a TRACON, the principal types of inputs provided by each of these facilities, TRACON functions, the facilities that are provided with outputs from a TRACON, and the principal

types of outputs provided to those facilities by the TRACON. The information flow for each function that was identified in Section 3.1 is then described in a separate series of paragraphs.

- TRACON Facilities Tentative Implementation Schedule (3.4). This section contains a figure that shows the tentative implementation schedule for the principal improvements affecting the TRACON Facilities.

- TRACON Facilities Interface Planning Summary (3.5). This section summarizes the major assumptions that were made in regard to: what improvements would be implemented, when they would be implemented, how they would function in a TRACON Facility, and how they would interact with other facilities.

3.1 TRACON Facilities Improvements Summary

Table 3-3 summarizes the TRACON Facilities Improvements that are planned for the Near Term and Far Term. The first four functions are concerned with software that is internal to the TRACON. Function 6 involves hardware changes within the TRACON. Function 5 and 7 involve hardware changes that are external to the TRACON, but whose implementation would cause changes in software, inputs, outputs, and displayed data within the TRACON. Each of these functions/features and the improvements in them are briefly described in the following paragraphs. In addition to the improvements that are listed in Table 3-3, there are other potential improvements whose implementation is less certain to occur. Such additional improvements are briefly described at the end of this section.

TABLE 3-3
TRACON FACILITIES IMPROVEMENTS SUMMARY
(ARTS III AND ARTS IIIA ONLY, UNLESS OTHERWISE DESIGNATED)

Functions/Features	Current System (1978)	Near Term Improvements (1979-82)	Far Term Improvements (Post-1982)
1. Monitoring Nearness to Ground	MSAW	Low Altitude Alerting System (TPX-42)	NC
2. Management of Traffic Flow in Terminal Areas	Manual	Manual	Terminal Metering and Spacing with Profile Descent
3. Determination of Immediate Potential Aircraft Conflicts	Manual	Terminal Conflict Alert*	• ATARS
4. Resolution of Immediate Potential Aircraft Conflicts	Manual	Manual	• ATARS • Terminal Conflict Resolution Advisory
5. Communication with Aircraft	Voice Radio (VHF & UHF)	NC	Data Link (DABS) Added
6. Input, Output, and Display Processing	ARTS III, TPX-42, FDEP	• ARTS III Upgraded to ARTS IIIA* • ARTS II*	• TIPS Added • TPX-42 Replaced by ARTS II or Programmable TPX-42
7. Processing and Display of Aircraft and Weather Surveillance Data; Tracking of Aircraft	Display of Video Search Radar Returns and Processed Beacon Target Replies	• Addition of SRAPs at TRACONS • Addition of Search Radar Tracking Through Returns Digitized by SRAP	• All-Digital Display • Addition of Display of Digitized Weather Data (Turbulence) • Display of Digitized Search Radar & Beacon Target Reports

* = Approved by the FAA for Implementation
NC = No Change Included in Current Plans
NA = Not Applicable

Monitoring Nearness to Ground

Currently, terminal MSAW (Minimum Safe Altitude Warning System) is operational at ARTS III sites. A similar capability, Low Altitude Alerting System, is expected to be implemented at TPX-42 sites in the Near Term. Other than that, no specific improvements are currently planned for this area in either the Near Term or Far Term. See 3.3.1 for further information.

Management of Traffic Flow Near Terminal Areas

Currently, terminal metering personnel manually calculate estimated times of arrival at runways, manually determine desirable spacing and sequencing of aircraft onto the runways, and manually determine the aircraft maneuvers that should be performed in order to achieve the desirable spacing and sequencing. Current plans do not call for changes in this area in the Near Term.

In the Far Term, Terminal Metering and Spacing (M&S) is expected to be implemented in ARTS IIIA TRACONs. Through computer software, M&S would automatically calculate the times of arrival if no actions are taken by controllers, and would also calculate the estimated arrival times that are needed for proper spacing of aircraft. M&S would provide speed reduction and maneuver timing information to aid metering personnel in achieving the desirable spacing and sequencing. Improvements in this area would help controllers minimize congestion, decrease delays, reduce fuel consumption (through use of Profile Descent and other techniques), and decrease noise in terminal areas.

Also in the Far Term, M&S would be integrated with Terminal Conflict Alert and En Route Metering. M&S would be dependent upon En Route Metering's delivery of aircraft to feeder fixes

within certain coarse time limits. In turn, Terminal M&S would provide En Route Metering with real-time metering and spacing information (runway acceptance rates, runway slot usage, or flight data for VFR (Visual Flight Rules) flights, Tower En Route flights, and Departures). M&S would also include an automated capability for analysis of the desirability of the use of Profile Descent and other fuel conservation methods for individual aircraft. See 3.3.2 for further information.

Determination of Immediate Potential Aircraft Conflicts

In the Near Term era, Terminal Conflict Alert is being implemented nationally. It provides automatic detection of immediate potential conflicts between aircraft in terminal areas. In the Far Term, Terminal Conflict Alert would be integrated with Terminal M&S in order to ensure conflict-free metering paths near terminals. It is expected that two other related functions, ATARS (Automated Traffic Advisory and Resolution Service) and BCAS (Beacon-based Collision Avoidance System) will be implemented in the Far Term. See 3.3.3 for further information.

Resolution of Immediate Potential Aircraft Conflicts

Currently, controllers must find their own solutions to conflict situations with little computer aid. Improvements in this area would automatically provide controllers with recommended actions to be taken in order to resolve conflicts that have been detected by the Terminal Conflict Alert function. No specific improvements are currently planned for the Near Term. In the Far Term, the Terminal Conflict Resolution Advisory function is expected to be implemented at ARTS IIIA TRACONs. The Conflict Resolution Advisory function would provide recommended solutions to conflicts that have reached an advanced state. It is

expected that two other related functions, ATARS and BCAS, will be implemented in the Far Term. The Conflict Resolution Advisory Function is dependent upon the implementation of Terminal Conflict Alert. See 3.3.4 for further information.

Communication with Aircraft

In order to perform their duties, controllers currently use two-way voice radio communication extensively. Improvements would relieve controllers of much of this work and would also decrease the load on the heavily-used terminal radio channels. No improvements in this area are currently planned for the Near Term. In the Far Term, Data Link (DABS) is expected to be implemented and available for use. Data Link would be able to provide rapid non-voice communication between the TRACON and aircraft. Many routine and high priority messages could be transmitted via Data Link. As yet, the manner in which Data Link would be used for communication between TRACONs and aircraft has not been fully determined. The use of Data Link is dependent on the implementation of DABS (Discrete Address Beacon System) and the implementation of a message generating and receiving capability that would interface with DABS Data Link and the TRACONs. See 3.3.5 for further information.

Input, Output, and Display Processing

Currently, Input, Output, and Display Processing are performed with FDEPs (Flight Data Entry and Printout equipment) and ARTS III, ARTS II, and TPX-42 systems that have limited capabilities. Improvements in this area would provide better, more timely information for TRACON controllers, would decrease the coordination workload, and would support VFR flight services.

In the Near Term, ARTS III sites will be upgraded to ARTS IIIA. In the Far Term, TIPS (Terminal Information Processing System) is expected to be implemented at all TRACONs and TRACABs. FDEPs would no longer be needed in the TRACONs/TRACABs as either input or output devices. All of the messages that currently can only be sent from a TRACON/TRACAB to its host ARTCC via FDEPs, would be capable of being entered through TIPS consoles. Furthermore, the ARTCC would no longer be required to route flight progress strip information to FDEPs in TRACONs and TRACABs. Instead, TIPS would prepare and display similar information from its extensive store of flight plan data that would be received from the host ARTCC as well as from FSSs and local entry devices. Also in the Far Term, it is expected that the TPX-42 equipment currently in operation at TRACON/TRACAB sites will be replaced either with ARTS II systems or Programmable TPX-42s. See 3.3.6 for further information.

<u>Processing and Display of Aircraft and Weather Surveillance Data; Tracking of Aircraft</u>

Currently, both digital and analog data are displayed on ARTS plan view displays. Data blocks and lists are displayed through digital techniques; aircraft and weather target data are displayed through (broadband) analog techniques. The brightness of broadband targets decreases as the radar scan moves away from them, and the displayed returns tend to be smeared. Improvements in this area are expected to provide controllers with more distinct, less variable display of search radar targets and beacon replies, more digital writing time, and greater selectivity and filtering of information to be displayed. Also, improved weather information (turbulence and wind shear in addition to precipitation) would be available and could be displayed.

In the Near Term, SRAP (Sensor Receiver and Processor) will be available as part of each ARTS IIIA. It will be used to digitize the search radar information needed for radar tracking and to digitize the beacon information that is currently digitized by the Beacon Data Acquisition Subsystem of ARTS III.

In the Far Term, all-digital displays are expected to replace the current broadband/digital displays at ARTS III sites. The new displays would provide the nonfading, discrete position symbols, etc. mentioned above. The ARTS II and TPX-42 sites are expected to continue using their current displays that provide digital tabular information, etc. and broadband display of aircraft and weather targets. For ARTS III sites, it is expected that broadband surveillance data would no longer be available. However, it is possible that the broadband capacity would be retained for backup to the digital surveillance data.

In the Far Term, digitized weather data is expected to be available via separate channels from terminal surveillance sites. Also, in the Far Term, the capability of obtaining and controlling the display of digitized three-dimensional turbulent weather is expected to be provided at ARTS III installations. See 3.3.7 for further information.

<u>Other Near Term and Far Term Improvements</u>

As mentioned in Chapter 2, it is expected that CWSUs (Center Weather Service Unit) will be located at each ARTCC. The CWSU in each ARTCC would provide automated collection and distribution of weather and PIREPs (Pilot Weather Report) to and from TRACONs. The CWSU would prepare and update tailored weather descriptions for TRACONs. These would be retrievable by terminal controllers at any time. The Aviation Weather

System Program Plan calls for the implementation of CWSUs by 1980. Although TRACONs might be able to make some use of CWSU capabilities in the Near Term, maximum automated aid is not proposed to be provided to TRACONs until TIPS would be available to interface with CWSUs in the Far Term. Weather information from CWSUs would then be displayed on TIPS displays.

Currently, numerous status displays are associated with airport communications, navigation, and surveillance facilities. In the Far Term, these would be replaced by the Airport Traffic Control Tower Consolidated Display (ACD) in each TRACON. The status data, as well as weather sensor indicators (wind, temperature, barometric pressure, etc.), would be integrated and consolidated into the ACD.

Additional Potential Improvements

Automated Terminal ATC is an additional potential improvement in the management of traffic flow near terminals. Thus far, experimental work on automated air traffic control has been confined to en route airspace (AERA = Automated En Route Air Traffic Control) up to the terminal feeder fixes. However, approval has been given for the investigation of the extension of the AERA concepts to include terminal airspace.

Another potential improvement is CMA (Control Message Automation). CMA would provide the link between the TRACON and DABS data link. CMA would handle functions such as formatting, bookkeeping, and the establishment and use of priorities for data link messages. CMA would handle messages that may be generated through functions/features such as Conflict Alert, Conflict Resolution Advisory, etc.

Another potential change is the replacement/augmentation of the terminal area computers (ARTS IIIA, ARTS III, ARTS II, TPX-42). As air traffic volume increases and software capabilities are added to TRACONs/TRACABs, the possibility of exceeding current hardware capabilities increases. Added incentives for change result from the equipment growing older and maintenance costs rising.

In the future, it may be desirable to exchange Conflict Alert and Conflict Resolution Advisory information between facilities (ARTCC and TRACON). This would be done so that both facilities could have the same conflict information for aircraft that are at, or near, the boundary between the two facilities. As currently performed, the Conflict Alert function at one facility might declare an alert for a pair of aircraft, but the Conflict Alert function at the adjacent facility might not declare an alert until a later time, or might not declare an alert at all. This could occur because of differences in scan rates, separation standards, conflict alert algorithms, and use or non-use of flight intent data. Similarly, in the future, one facility might provide a conflict resolution advisory before another facility, and the maneuvers recommended in the two advisories might not be the same. Considering this lack of common conflict information, it may be desirable to exchange such information between adjacent facilities.

In the Far Term, as previously mentioned, the information to be displayed on situation (plan view) displays will be all-digital rather than the current mixture of analog and digital information. In order to provide a smooth transition between the two, it may be desirable to have a display device that can function with either type of input. The Full Digital ARTS

Display (FDAD) is being specified to provide such a capability. FDAD as currently envisioned could also provide color (multi-chromatic) displays, internal memory, buffer refresh capability, programmable functions, and interfacing capabilities for ARTS IIIA, ARTS III, and ARTS II.

3.2 TRACON Facilities System Connectivity

Figures 3-1, 3-2, and 3-3 show respectively, the Current, Near Term, and Far Term connections between an ARTS III(A) TRACON and other elements of the ATC system. The figures do not show the specific connectivity for TRACABs and TPX-42s. As previously mentioned, the emphasis in this chapter is on ARTS IIIA TRACONs -- the highest level of terminal automation. The TRACONs and TRACABs that have ARTS II or TPX-42 automation equipment do not have all of the functions and are not connected to all of the elements indicated in the figures. ARTS II functional capability and connectivity are similar to ARTS IIIA but more limited. The capability of TPX-42 equipment is much more limited, and the equipment itself is connected only to terminal surveillance sites.

The principal changes in connectivity from the Current system to the Near Term system are shown in italic type in Figure 3-2. Changes in complete functions and groups of improvcments are further emphasized by being enclosed in blocks outlined with heavy broken lines. Similarly, italics and heavy, broken lines are used in Figure 3-3 to indicate the principal changes in connectivity from the Near Term system to the Far Term system. These changes are briefly described in the following paragraphs.

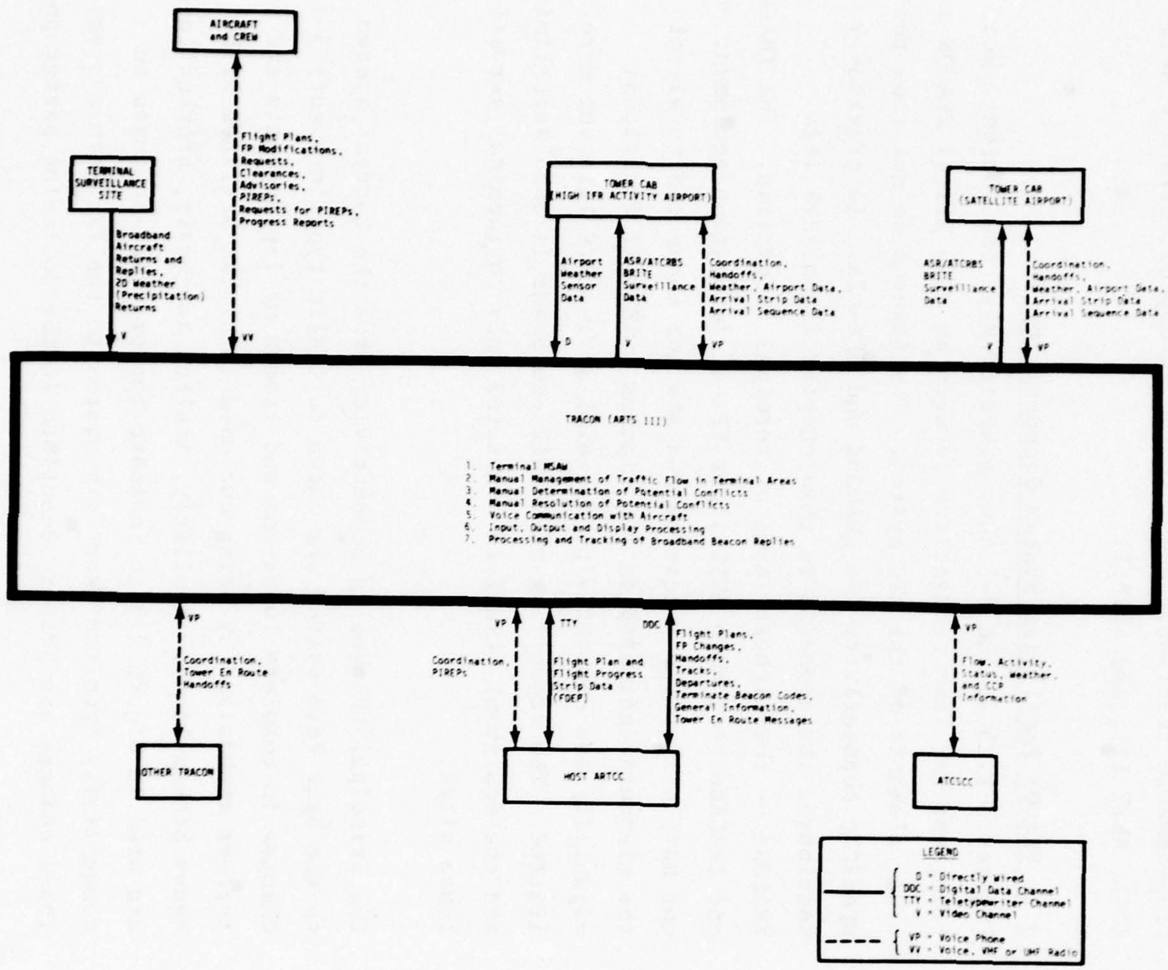
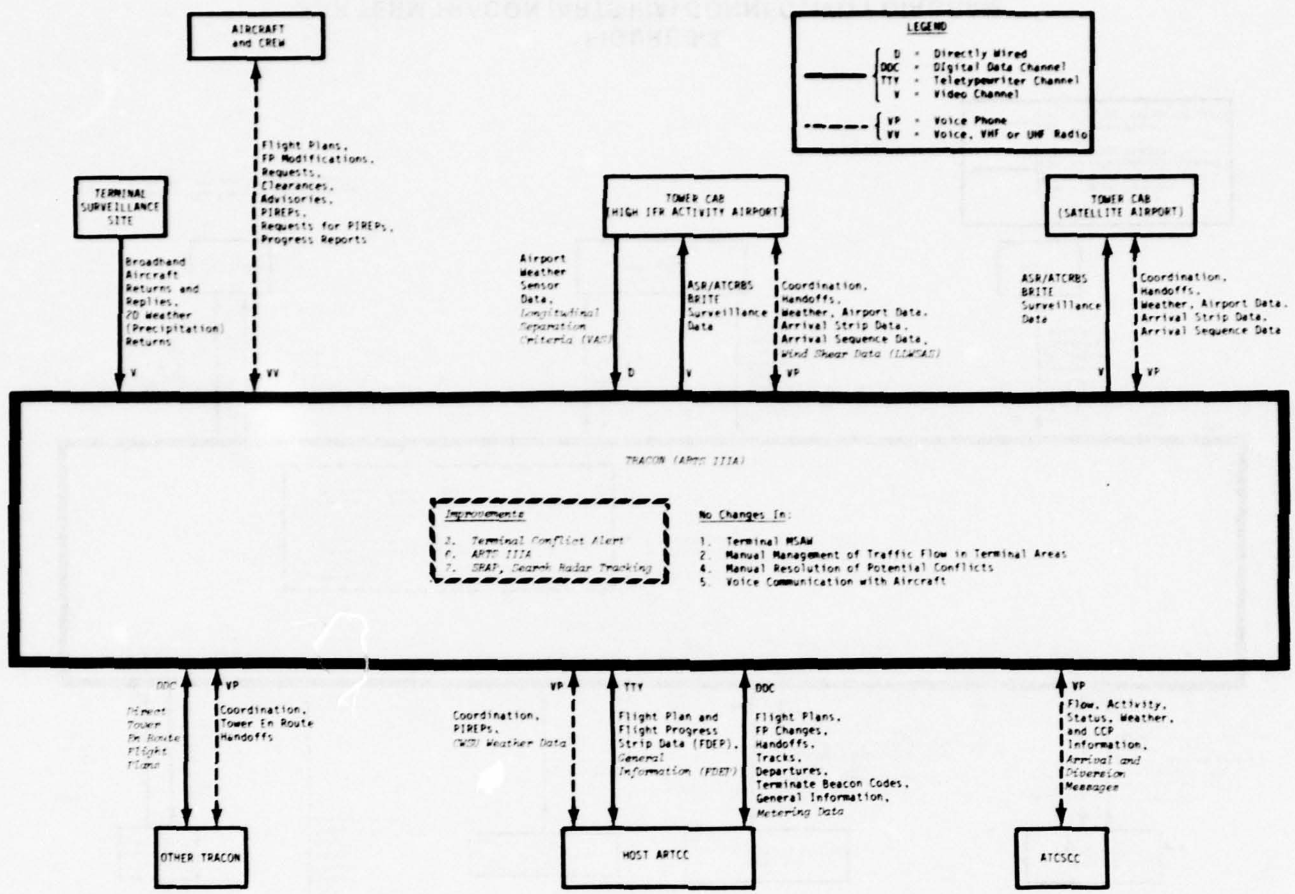


FIGURE 3-1
CURRENT TRACON (ARTS III) CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 3-2
NEAR TERM TRACON (ARTS IIIA) CONNECTIVITY DIAGRAM

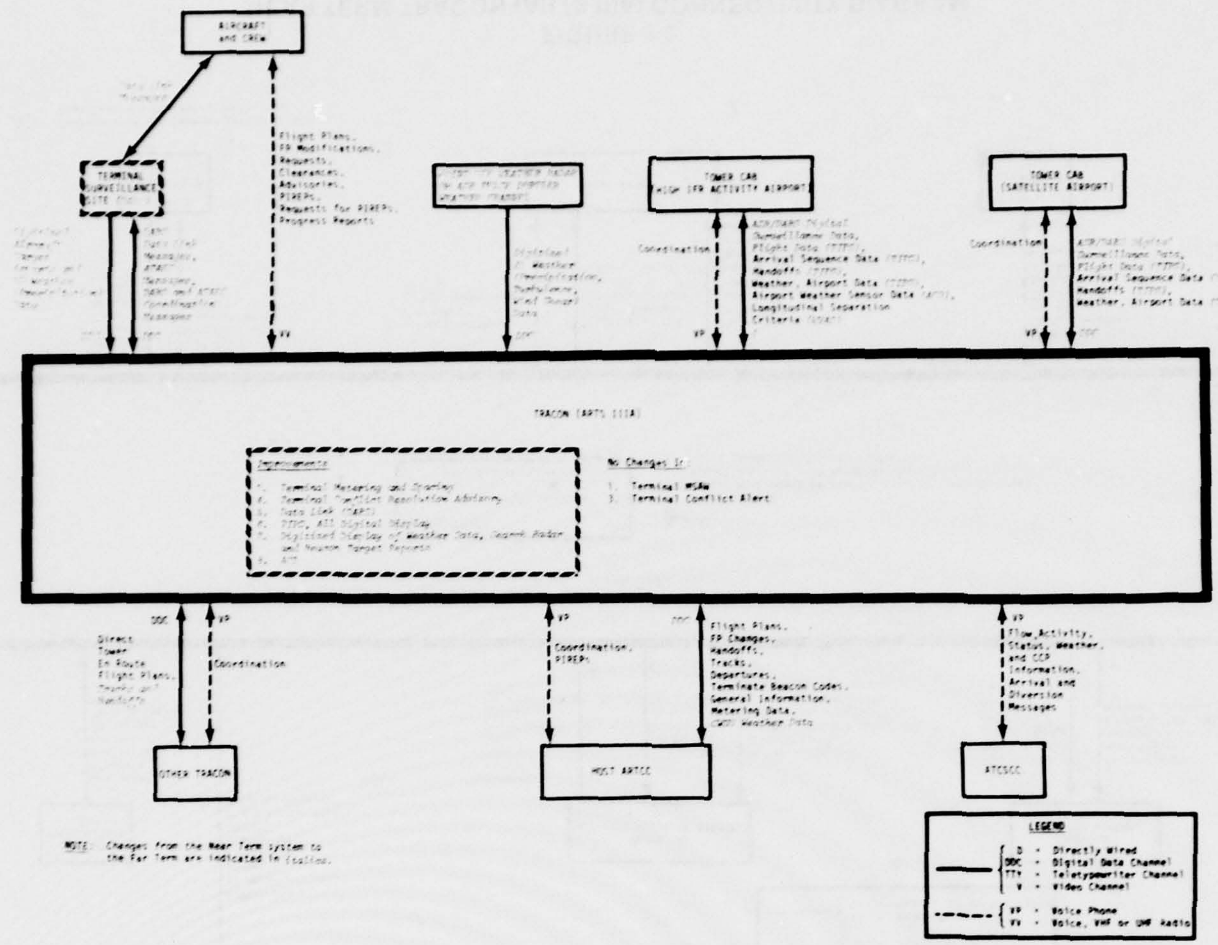


FIGURE 3-3
FAR TERM TRACON (ARTS IIIA) CONNECTIVITY DIAGRAM

Near Term

In the Near Term, Longitudinal Separation Criteria data from VAS (Vortex Advisory System) and Wind Shear data from LLWSAS (Low Level Wind Shear Alert Systems) are expected to become available from Tower Cabs at major airports. Tower En Route Flight Plans would be transmitted directly from TRACON to TRACON instead of being sent via ARTCCs. Information on aircraft arrivals and diversions is expected to be sent via voice to the ATCSCC (Air Traffic Control Systems Command Center) from the TRACON for use in Central Flow Control Calculations. Metering data would be exchanged between TRACONs and En Route Metering. Weather information, especially prepared for use by TRACON controllers, would be available from the CWSU at the host ARTCC.

Far Term

In the Far Term, Data Link capabilities are expected to be available through DABS. The TRACON would be able to send messages to the terminal surveillance sites for uplinking to aircraft, and would receive (from the surveillance sites) messages that had been downlinked from aircraft. Controller Alerts generated by ATARS would be sent to the TRACON as would be indications of the ATARS recommended avoidance maneuvers that were sent to aircraft and the responses of the pilots. A TRACON would receive its principal weather information from one of three sources: (1) an ASR (Airport Surveillance Radar) Weather Channel from the Terminal Surveillance Site, or (2) an ASR Pulse Doppler Weather Channel from the Terminal Surveillance Site, or (3) a Joint Use Weather Radar Site. The first of the three sources would provide only two-dimensional precipitation information. The other two sources would provide three-dimensional precipitation information plus information on turbulence and wind shear. The Longitudinal Separation Criteria data and Wind

Shear data that had previously been supplied by VAS and LLWSAS would be supplied by WVAS (Wake Vortex Avoidance System) and AWSDS (Advanced Wind Shear Detection System). Metering data would be exchanged between Terminal M&S and En Route Metering. For Tower En Route flights, Tracks and Handoff messages would be sent between TRACONs via digital data channels. These handoffs would no longer require voice communications between controllers at the different TRACONs. TIPS is expected to be implemented in the Far Term. It would be internal to the TRACON, and would be connected to the ARTS computer, the host ARTCC, adjacent TRACONs, local Tower Cabs, and remote Tower Cabs. It is expected that all-digital PVDs would be used at all ARTS III sites. All surveillance data (aircraft and weather) would be received in digital form and would be displayed on the all-digital PVDs. Airport status and weather data would be consolidated into the ACD (Airport Traffic Control Tower Consolidated Display).

3.3 TRACON Facilities Information Flow

Figures 3-4, 3-5, and 3-6 show respectively, the Current, Near Term, and Far Term information flow between an ARTS III TRACON and other elements of the ATC system. In each figure, the TRACON is shown as a large box in the middle. The inputs to the TRACON are shown to the left of the box; the outputs from the TRACON are shown to the right. The box itself contains the names of most of the major functions that are performed within a TRACON and very brief descriptions of how the named functions are expected to be performed at the end of the period (Current, Near Term, or Far Term) for which the figure has been prepared. The inputs and outputs that are listed are the general types of inputs and outputs for a TRACON, not the total set of input and output message types.

INPUTS

From Terminal Surveillance Site
- Search Radar
  - Broadband (Video) Aircraft and Weather Returns (Two-dimensional) (range, azimuth)

  ATCRBS
  - Broadband Aircraft Replies (range, azimuth, identification, altitude)

From the Host ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Strip Data (FDEP)
- General Information Messages
- Tower En Route Messages
- PIREPs
- Coordination

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPs
- Requests for Information
- Progress Reports

From Tower Cab (High IFR Activity Airport)
- Coordination
- Handoffs
- Weather and Airport Data
- Airport Weather Sensor Data

From Tower Cab (Satellite Airport)
- Handoffs
- Weather and Airport Data

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Requests for Situation Reports
- Arrival and Departure Delay Predictions

From Other TRACON Facility
- Tower En Route Handoffs

Current TRACON Facility (ARTS III)
FUNCTIONS
1. Monitoring Nearness to Ground Terminal Minimum Safe Altitude Warning System ARTS III automatically checks aircraft for safe altitudes
2. Management of Traffic Flow in Terminal Areas Manual calculation of runway arrival times Manual determination of maneuvers required to provide spacing and correct arrival times
3. Determination of Immediate Potential Aircraft Conflicts Manual prediction of conflicts
4. Resolution of Immediate Potential Aircraft Conflicts Controllers manually evaluate and resolve potential conflicts
5. Communication with Aircraft Voice radio
6. Input, Output, and Display Processing Through ARTS III
7. Processing and Display of Aircraft and Weather Surveillance Data; Tracking of Aircraft Display of broadband (video) aircraft and weather search radar (ASR) returns and aircraft beacon (ATCBI) replies Tracking of Aircraft through Beacon Surveillance Data

To the Host A
- Handoff
- Departur
- Terminal
- Flight P
- General
- Tower En
- PIREPs
- Coordina

To Aircraft (
- Clearanc
- FP Modif
- Instruct
- Requests

To Tower Cab
- Coordina
- Arrival
- Handoffs
- Weather
- ASR/ATCB

To Tower Cab
- Arrival Strip
- Handoffs
- Weather
- ASR/ATCB

To ATCSCC
- Situatio equip
- Requests Impend

To Other TRAC
- Tower En

titudes

e

e

conflicts

lance Data;

rch radar

s

OUTPUTS

To the Host ARTCC

- Handoff and Position Messages
- Departure Messages
- Terminal Beacon Code Messages
- Flight Plan Data (FDEP)
- General Information Messages (FDEP)
- Tower En Route Messages
- PIREPs
- Coordination

To Aircraft (Air Crew)

- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To Tower Cab (High IFR Activity Airport)

- Coordination
- Arrival Sequence Data and Arrival Flight Strip Data
- Handoffs
- Weather Data
- ASR/ATCBI BRITE Surveillance Data

To Tower Cab (Satellite Airport)

- Arrival Sequence Data and Arrival Flight Progress *Strip Data*
- Handoffs
- Weather Data
- ASR/ATCBI BRITE Surveillance Data

To ATCSCC

- Situation Reports (personnel staffing, local weather, equipment status, radio frequencies, problem areas)
- Requests for Assistance in Handling Calamities or Impending Calamities

To Other TRACON Facility

- Tower En Route Handoffs

FIGURE 3-4
CURRENT TRACON FACILITIES—(ARTS III)
INFORMATION FLOW DIAGRAM

2

INPUTS

From Terminal Surveillance Site
- **Search Radar**
  - **Broadband Aircraft and Weather Returns** (two-dimensional) **(range, azimuth)**
- ATCRBS
  - **Broadband Aircraft Replies** (range, azimuth, identification, altitude)

From the Host ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Progress Strip Data (FDEP)
- General Information Messages
- PIREPs
- *CWSU Weather Data*
- *Metering Data*

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPs
- Requests for Information
- Progress Reports

From Tower Cab (High IFR Activity Airport)
- Coordination
- Handoffs
- Weather and Airport Data
- *Longitudinal Separation Criteria (VAS)*
- *Wind Shear Data (LLWSAS)*
- Airport Weather Sensor Data

From Tower Cab (Satellite Airport)
- Handoffs
- Weather and Airport Data

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Requests for Situation Reports
- Arrival and Departure Delay Predictions

From Other TRACON Facility
- Tower En Route Handoffs
- *Direct Tower En Route Flight Plans*

Near Term TRACON Facility (ARTS IIIA)

F U N C T I O N S

1. Terminal Minimum Safe Altitude Warning System
   ARTS IIIA automatically checks aircraft for safe altitudes (no change)
2. Management of Traffic Flow in Terminal Areas
   Manual calculation of runway arrival times
   Manual determination of maneuvers required to provide spacing and correct arrival times
3. Terminal Conflict Alert
   ARTS IIIA will predict potential conflicts
4. Resolution of Potential Conflicts
   Controllers manually evaluate and resolve potential conflicts
5. Communication with Aircraft
   Voice radio (no change)
6. Input, Output, and Display Processing
   ARTS III Upgraded to ARTS IIIA
7. Processing and Display of Aircraft and Weather Surveillance Data; Tracking of Aircraft
   Display of broadband (video) aircraft and weather search radar (ASR) returns and aircraft beacon (ATCBI) replies
   Tracking of aircraft through Beacon *and Search Radar* Data
   Addition of SHAPs at TRACONs

Italics = change from previous version of system

To the Host ARTCC
- Handoff and P
- Departure Mes
- Terminate Bea
- Flight Plan D
- General Infor
- PIREPs
- *Metering Data*

To Aircraft (Air C
- Clearances
- FP Modificati
- Instructions,
- Requests for

To Tower Cab (High
- Arrival Seque
- Handoffs
- Weather Data
- ASR/ATCBI BRI
- Coordination

To Tower Cab (Sate
- Arrival Seque
- Handoffs
- Weather Data
- ASR/ATCBI BRI

To ATCSCC
- Situation Repo
  status, radi
- Requests for A
  Calamities
- *Arrival and Di*

To Other TRACON Fac
- Tower En Route
- *Direct Tower E*

OUTPUTS

To the Host ARTCC
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDEP)
- General Information Messages (FDEP)
- PIREPs
- *Metering Data*

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To Tower Cab (High IFR Activity Airport)
- Arrival Sequence Data and Arrival Flight Progress St
- Handoffs
- Weather Data
- ASR/ATCBI BRITE Surveillance Data
- Coordination

To Tower Cab (Satellite Airport)
- Arrival Sequence Data and Arrival Flight Progress Str
- Handoffs
- Weather Data
- ASR/ATCBI BRITE Surveillance Data

To ATCSCC
- Situation Reports (personnel staffing, local weather, status, radio frequencies, problem areas)
- Requests for Assistance in Handling Calamities or Im Calamities
- *Arrival and Diversion Messages*

To Other TRACON Facility
- Tower En Route Handoffs
- *Direct Tower En Route Flight Plans*

FIGURE 3-5
NEAR TERM TRACON FACILITIES—(ARTS IIIA)
INFORMATION FLOW DIAGRAM

2

INPUTS

From Terminal Surveillance Site
- Search Radar
  - *Digitized Aircraft Target Reports (range, azimuth)*
  - *Digitized Two-dimensional or Three-dimensional Weather Data*
- *DABS*
  - *Digitized DABS/ATCRBS Aircraft Target Reports (range, azimuth, identification, altitude)*
- *DABS Data Link*
- *DABS ATARS*
  - *Controller Notification of Aircraft Collision Avoidance Advisories*

From Joint Use Weather Radar Site
- *Digitized Three-dimensional Weather Data*

From the Host ARTCC *with TIPS Data Interface*
- Flight Plans, FP Changes
- Handoff and Track Messages
- General Information Messages
- Metering Data
- CWSU Weather Data

From Aircraft (Air Crew, *Data Link Available*)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPs
- Requests for Information
- Progress Reports

From Tower Cab (High IFR Activity Airport)
- Coordination
- Handoffs
- Weather and Airport Data
- Longitudinal Separation Criteria *(WVAS)*
- Wind Shear Data *(AWSDS)*
- Airport Weather Sensor Data *(ACD)*

From Tower Cab (Satellite Airport)
- Handoffs
- Weather and Airport Data

From ATCSCC
- Assistance in Handling Calamities or Impending Calamities
- Requests for Situation Reports
- Arrival and Departure Delay Predictions

From Other TRACON Facility
- Direct Tower En Route Flight Plan, *Handoff, and Track Messages*

Far Term TRACON Facility (ARTS IIIA)

FUNCTIONS

1. Terminal Minimum Safe Altitude Warning System
   ARTS IIIA automatically checks aircraft for safe altitudes (no change)
2. Terminal Metering and Spacing
   ARTS IIIA would plan arrivals and departures considering multiple runways, VFR flights, Profile Descents, etc.
   ARTS IIIA would provide suggested means of resolving problems in spacing, arrival times, etc.
   M&S would be integrated with Terminal Conflict Alert and provided with an automated interface with En Route Metering
   M&S would provide real-time automated analysis of the application of various fuel conservation methods (including Profile Descent) to specific aircraft
3. Terminal Conflict Alert
   ARTS III would predict potential conflict without current altitude and area limitations (no change)
   Terminal Conflict Alert would be integrated with M&S
4. Terminal Conflict Resolution Advisory
   ARTS IIIA would determine maneuvers to avoid conflict
   ARTS IIIA would provide controllers with resolution advisories
5. Communication with Aircraft
   Data Link (DABS) available in addition to voice radio
6. Input, Output, and Display Processing
   TIPS would store large flight data base
   TIPS would provide tabular data that would replace the flight progress strips currently timed, prepared, and routed by the ARTCC
   TIPS would provide controller-selectable alternative data for lists and data blocks on the ARTS PVDs
   TIPS would provide flight data displays to Tower and TRACON personnel
   TIPS would display weather, NOTAMs, and other operational data
7. Processing and Display of Aircraft and Weather Surveillance Data; Tracking of Aircraft
   Addition of display of digitized weather
   Digitized aircraft target reports used for display instead of broadband data
8. *Airport Traffic Control Tower Consolidated Display (ACD)*

Italics = change from previous version of system

To Terminal Surveillan
- *DABS Data Link*

To the Host ARTCC *with*
- Handoff and Positi
- Departure Message
- Terminate Beacon C
- Flight Plan Data
- General Informatio
- Metering Data
- PIREPs

To Aircraft (Air Crew,
- Clearances
- FP Modifications
- Instructions, Advi
- Requests for PIREP

To Tower Cab (High IFR
- Coordination
- Arrival Sequence D
- Handoffs
- Weather Data
- ASR/*DABS Digital* S

To Tower Cab (Satellite
- Arrival Sequence D
- Handoffs
- Weather Data
- ASR/*DABS Digital* S

To ATCSCC
- Situation Reports (equipment status,
- Requests for Assis Impending Calami
- Arrival and Divers

To Other TRACON Facilit
- Direct Tower En Ro *Messages*

OUTPUTS

To Terminal Surveillance Site
- *DABS Data Link*

To the Host ARTCC *with TIPS Data Interface*
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data
- General Information Messages
- Metering Data
- PIREPs

To Aircraft (Air Crew, *Data Link Available*)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIRFPs

To Tower Cab (High IFR Activity Airport)
- Coordination
- Arrival Sequence Data and *Flight Data (TIPS)*
- Handoffs
- Weather Data
- ASR/*DABS Digital* Surveillance Data

To Tower Cab (Satellite Airport)
- Arrival Sequence Data and *Flight Data (TIPS)*
- Handoffs
- Weather Data
- ASR/*DABS Digital* Surveillance Data

To ATCSCC
- Situation Reports (personnel staffing, local weather, equipment status, radio frequencies, problem areas)
- Requests for Assistance in Handling Calamities or Impending Calamities
- Arrival and Diversion Messages

To Other TRACON Facility
- Direct Tower En Route Flight Plan, *Handoff, and Track Messages*

FIGURE 3-6
FAR TERM TRACON FACILITIES—(ARTS IIIA)
INFORMATION FLOW DIAGRAM

2

Italic type is used in Figure 3-5 to indicate the principal changes in information flow and functions from the Current system to the Near Term system. Similarly, italics are used in Figure 3-6 to indicate the principal changes from the Near Term system to the Far Term system. The changes in functions, the inputs to the functions, and the outputs from the functions are described in the following paragraphs.

3.3.1 Monitoring Nearness to Ground

In this area, the Low Altitude Alerting System is expected to be implemented at TPX-42 sites in the Near Term. No other specific improvements are currently planned for this area in either the Near Term or Far Term.

Currently, terminal MSAW is operational at ARTS III sites. MSAW uses computer software to compare aircraft altitudes to the minimum safe altitudes of the areas in which the aircraft are flying. MSAW generates visual and aural alerts to the controller when an aircraft is at, or will in the near future be at, an unsafe altitude. MSAW monitoring is provided for Approach Paths and General Terrain. Approach Path Monitoring is accomplished by checking the tracks of all MSAW-eligible aircraft for their positions relative to runways at the major airport. If a track qualifies for a particular runway, the approach monitoring function will check for any violation of the specified final approach area altitude. General Terrain monitoring is applied to all aircraft that are in the terminal area but are not on approach paths. General Terrain monitoring is accomplished by comparing a track's reported and predicted altitudes to the minimum altitude assigned to each bin through which the track passes. (Each bin is a square whose sides are two miles long.)

All inputs that are required by MSAW come from within the TRACON. All outputs go to controllers within the TRACON. Inputs required by MSAW are:

- minimum safe altitudes for the areas being checked. Obtained from the ARTS III Adaptation data base.
- aircraft altitudes. Obtained from the ARTS III Automatic Tracking program.

Outputs provided by MSAW are:

- displayed warnings. Provided on the PVDs of the appropriate controllers.
- aural warnings. Provided at the sector control positions of the appropriate controllers.

3.3.2 Management of Traffic Flow Near Terminals

In the Current system, metering and spacing is performed manually. Terminal metering personnel or controllers manually calculate estimated times of arrival at runways, determine desirable spacing and sequencing of aircraft onto the runways, and determine the aircraft maneuvers that should be performed in order to achieve the desirable spacing and sequencing.

No specific improvements are currently planned for the Near Term. In the Far Term, Terminal Metering and Spacing (M&S) is expected to be implemented at ARTS III sites. M&S would help controllers control the arrival and departure of aircraft in the terminal area so that safe, efficient use could be made of the runways.

M&S would attempt to have aircraft arrive at the runways in the proper sequence and with proper separation from other arriving and departing aircraft.

M&S (Reference 3-2) would provide terminal controllers with information that would help them plan any delays, holds, and speed corrections that may be needed to achieve proper sequencing and spacing of aircraft. M&S would include Profile Descent Paths, and ultimately would include planning for multiple runways, VFR flights, and departures.

Much work has been accomplished in the design and testing of preliminary versions of M&S. However, it is expected that much more work will be required before the implementable version of M&S can be completely specified. Therefore, the descriptive information in the following paragraphs should be considered very tentative.

Inputs that would be required by M&S are:

- velocity and current position information. Obtained from ARTS III automatic tracking program.
- aircraft type. Obtained from flight plans from the host ARTCC, adjacent TRACON, etc.
- Longitudinal Separation Criteria Data. Obtained from Tower Cab.

Outputs that would be provided by M&S are:

- data block information for each metered aircraft. Provided on terminal controllers' plan view displays.

- number of seconds that the aircraft must be delayed.

- specific heading, altitude, or speed to which the aircraft should be told to change at this time.

- an indication of whether or not the aircraft is flying a Profile Descent path.

● tabular data. Provided on terminal controllers' PVDs.

- flight plan information for those aircraft that are to use the runways within approximately the next five minutes.

- a hold indication for those aircraft that should be held.

- expected time over feeder fix for each aircraft.

- amount of delay time that should be imposed on each aircraft considering its expected time of arrival at its feeder fix.

- real-time wind data calculated from tracking results versus assigned aircraft headings.

- preview of next maneuvering command that will be presented to controller.

● proposed time of departure from feeder fixes for each arriving aircraft. Digital data messages sent to host ARTCC for use by En Route Metering.

- current aircraft acceptance rate for each runway. Digital or voice data sent to host ARTCC for use by En Route Metering.

- flight information for each terminal aircraft (VFR, Tower En Route, or Departure) or runway slot reservations. Digital or voice data sent to host ARTCC for use by En Route Metering.

Although three types of information are listed as being sent to En Route Metering, probably only one or two types would be sent once the design has been finalized.

Also in the Far Term, M&S would be integrated with Terminal Conflict Alert and En Route Metering. M&S would be dependent upon En Route Metering's delivery of aircraft to feeder fixes within certain coarse time limits. In turn, Terminal M&S would provide En Route Metering with real-time metering and spacing information (runway acceptance rates, runway slot usage, or flight data for VFR flights, Tower En Route flights, and Departures). M&S would also include an automated capability for analysis of the desirability of the use of Profile Descent and other fuel conservation methods for individual aircraft.

3.3.3 Determination of Immediate Potential Aircraft Conflicts

In the Current system, the detection of potentially hazardous situations between aircraft pairs has been performed manually by terminal controllers.

In the Near Term, Terminal Conflict Alert is being implemented at all ARTS III sites. Terminal Conflict Alert automatically detects potentially hazardous situations between aircraft pairs

and warns controllers of these situations. Implementation is occurring in two stages. The first stage of capability functions only for pairs of aircraft each of which is controlled and is supplying Mode C altitude reports. The second stage of capability would provide the capabilities of the first stage, and in addition, would function for pairs of aircraft consisting of one that is controlled and is supplying Mode C altitude reports and another that is uncontrolled, but is supplying Mode C altitude reports.

The determination by Terminal Conflict Alert of when a conflict alert should be declared is through the use of three detection modules. One predicts conflicts assuming that the tracks will maintain constant speed and straight line paths. Another predicts conflicts based on continued maneuvering of an aircraft pair in the direction in which either or both aircraft are already maneuvering. The third module does not use prediction; it bases its warning on the proximity of aircraft to each other. Each of these detection modules is highly parameterized. Different parameter sets are tailored for each of three types of airport areas that have been defined. The three types are: areas around major or satellite airports, extensions of the areas around major or satellite airports, and any remaining area not included in the first two types.

Inputs to Terminal Conflict Alert are:

- positional information. Obtained from the ARTS III Automatic Tracking program.
- airport area geographic information. Obtained from the ARTS III Adaptation data base.

Outputs from Terminal Conflict Alert are:

- displayed warnings. Provided on the situation (plan view) displays of the appropriate terminal controllers.
- aural warnings. Provided at the sector control positions of the appropriate controllers.

In the Far Term, it is expected that an automated interface will be developed between Terminal Conflict Alert and M&S so that M&S advisories will provide aircraft with conflict-free paths. Related improvements in detecting potential conflicts are expected to be made through systems that would not be contained within TRACON rooms. Specifically, BCAS and ATARS are planned for implementation in the Far Term. These functions were previously described in 2.3.4.

3.3.4 Resolution of Immediate Potential Aircraft Conflicts

Currently, controllers must find their own solutions to conflict situations with little computer aid. No Near Term improvements are currently planned. In the Far Term, the Terminal Conflict Resolution Advisory function is expected to be implemented. It would provide controllers with recommendations as to maneuvers to be taken by aircraft in order to avoid collision. Inputs that would be required by the Conflict Resolution Advisory function are:

- positional information for each aircraft that is in potential conflict. Obtained from the ARTS III Automated Tracking function and/or Conflict Alert function.

- indications of potential conflicts. Obtained from the ARTS III Conflict Alert function.
- terrain avoidance or geographic environment information. Obtained respectively from terminal MSAW and the ARTS III Adaptation data base.

Outputs from the Conflict Resolution Advisory function would be:

- resolution advisories. Provided to appropriate terminal controllers.

Also in the Far Term, the related functions, BCAS and ATARS, are expected to be implemented. These functions would not be contained within TRACON rooms. Both of these functions would provide recommended solutions to conflict situations directly to the pilots of equipped aircraft. They were previously described in 2.3.4.

3.3.5 Communication with Aircraft

No specific improvements in this area are currently planned for the Near Term. Data Link (DABS) is expected to be available in the Far Term to provide rapid non-voice communication between the TRACON and aircraft. However, as yet, its use for communication between TRACONs and aircraft has not been fully determined. The applications that are currently the most favored candidates for initial implementation are: ATARS, altitude assignment confirmation, MSAW advisories, take-off clearance confirmation, digital ATIS (Automated Terminal Information System), real-time active runway surface winds, hazardous weather advisories, routine weather data on request, and real-time RVR (Runway Visual Range). Applications favored for later implementation are:

Metering and Spacing commands, pre-departure weather, flight plan clearance, route-oriented weather, status of Category II/III precision approach protected areas, frequency assignment, heading/speed instructions, holding instructions, airborne situation display, and downlinked weather.

3.3.6 Input, Output, and Display Processing

In the Current system, Input, Output, and Display Processing are performed through the data processing capabilities that are currently available in a TRACON or TRACAB. These capabilities -- one or more FDEPs and an ARTS III, ARTS II, or TPX-42 -- are limited as to speed, storage, and computing capacity to the point that they might not be able to be adequate considering the predicted traffic load and expected functional additions.

In the Near Term, ARTS III sites will be upgraded to ARTS IIIA. In the Far Term, it is expected that the TPX-42 equipment currently in operation at TRACON/TRACAB sites will be replaced with a more sophisticated system. ARTS II and a programmable version of the TPX-42 are the principal candidate replacement systems. A decision on replacement is expected in 1980. Also in the Far Term, TIPS (Terminal Information Processing System) is expected to be implemented at all TRACONs (and TRACABs). TIPS would provide all of the capabilities currently provided by FDEP. TIPS would improve the availability and timeliness of flight data presentations to TRACON (and Tower Cab) controllers, reduce the controller coordination workload, and support VFR flight services. TIPS would accept, process, distribute, and display flight and other non-radar data for an entire terminal area, including the TRACON and its associated Tower Cab(s). TIPS would provide the means by which flight and control data would be exchanged between devices within a Tower Cab, between Tower

Cabs, between a Tower Cab and its associated TRACON, and between a TRACON and its host ARTCC. TIPS would also provide controllers with NOTAMs (Notice to Airmen), weather data (including the especially tailored weather briefings prepared by the CWSU at the host ARTCC), and other operational information.

Currently, most flight data from the host ARTCC is printed as Flight Progress Strips on FDEPs. These strips must be marked and distributed by TRACON and Tower Cab controllers. Coordination among various control positions requires much voice communication. with TIPS, full flight data could be displayed for IFR and VFR flights. Most voice coordination work would be replaced by simple computer entries made by controllers. In a TRACON, TIPS would provide individual Display and Data Entry Units for the Arrival Data and Departure Data Positions. TIPS (through ARTS) would also provide additional PVD (Plan View Display) capabilities. Radar Controllers would be able to chose alternative data to be displayed in lists and data blocks on their PVDs. A three-position switch at each console would allow the Radar Controller to choose among: Normal, Fix/Altitude, or Aircraft Data (or other types of data if the TRACON is so adapted).

Inputs to TIPS would be:

- IFR flight plans and flight plan changes. Obtained from the host ARTCC, Adjacent TRACONs (Tower En Route flights), and keyboard entries by terminal controllers.
- VFR flight plans and flight plan changes. Obtained from adjacent TRACONs and keyboard entries made by terminal controllers.

- Handoff, Track, and General Information messages. Obtained from the host ARTCC and adjacent TRACONs.
- Weather Briefings. Obtained from the CWSU in the host ARTCC.
- Miscellaneous data to be stored, processed, or forwarded. Obtained from the ARTS III system.

Outputs from TIPS would be:

- Flight plans and flight plan changes (Tower En Route and VFR). Sent to adjacent TRACONs.
- Displays of alternative list and data block data. Provided to TRACON Radar Controllers through ARTS III.
- Handoff, Track, General Information, Departure Messages. Sent to the host ARTCC and adjacent TRACONs.
- Terminate Beacon Code messages. Sent to host ARTCC.
- Miscellaneous data to be displayed or transmitted at the request of the ARTS III system. Sent to terminal controllers or host ARTCC.
- Requests for Weather Briefings. Sent to CWSU at the host ARTCC.

3.3.7 Aircraft and Weather Surveillance Information Handling

Currently, the aircraft and weather target data that is displayed to ARTS III TRACON controllers is broadband data. The present displays and displayed data have a number of undesirable characteristics. The brightness of the displayed targets on the

PVDs gradually decreases after the rotating radar/beacon beam "paints" the targets. The displayed targets tend to be smeared lines rather than discrete targets. Digital writing time is severely limited since it is limited to "radar dead time." Display selectivity is very limited. All-digital display equipment and digitized weather displays are expected to provide ARTS III controllers with more selectivity and clearer, more accurate information.

In the Near Term, a SRAP will be installed as part of each ARTS IIIA site. SRAP will be used to digitize the search radar information needed for radar tracking.

In the Far Term, all-digital displays are expected to replace the current broadband/digital displays at ARTS III sites. The new displays would provide nonfading, discrete position symbols, increased display selectivity, and additional digital writing time. The ARTS II and TPX-42 sites are expected to continue using their current displays that provide digital tabular information, etc. and broadband display of aircraft and weather targets. For ARTS III sites, it is expected that broadband surveillance data would no longer be available. However, no firm decision has been made, and it is therefore possible that the broadband capability would be retained as backup for the digital surveillance data.

The inputs and outputs for the all-digital displays would be internal to ARTS III. Inputs would be the information that is to be displayed at specific display coordinates. Outputs would be digital target and weather data displayed on Radar Controllers' PVDs.

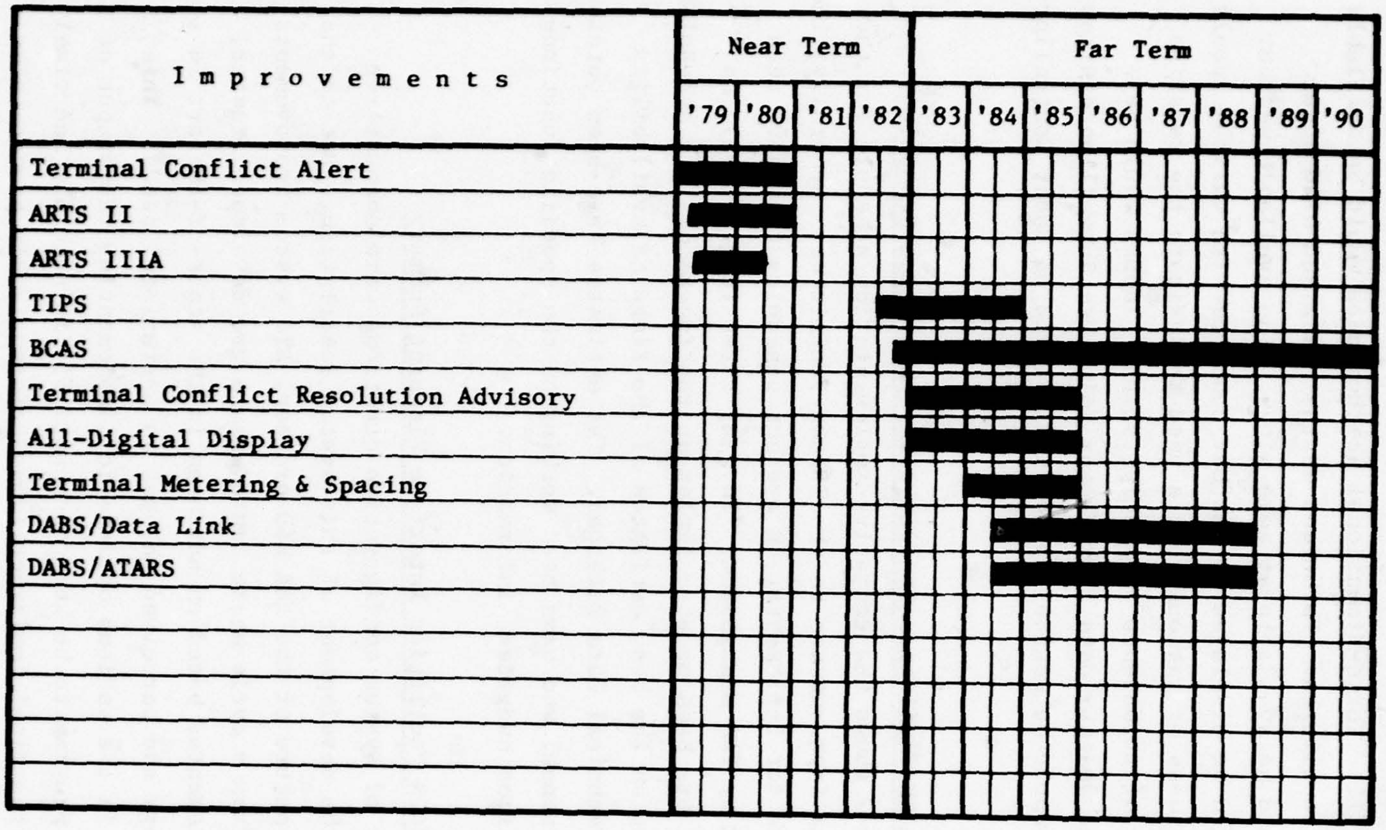
Also in the Far Term, digitized weather data would be provided to ARTS III. Three-dimensional weather data would be available at some facilities. Turbulent weather data and wind shear data would be available at some sites. The available weather data could be displayed as weather contours with various levels of brightness or various colors used to indicate the relative severity of turbulence or precipitation. Inputs would be digitized weather data from FAA or Joint Use Surveillance Sites. Outputs would be weather contours displayed on Radar Controllers' PVDs.

3.4 TRACON Facilities Tentative Implementation Schedule

Figure 3-7 shows the tentative implementation schedule for the principal improvements to the TRACON Facilities. Generally, the schedules for implementation are not schedules that have been approved by FAA management. In many cases (e.g., TIPS), no decision has been made to implement the function. The schedules are based on the best estimates of the times of availability of the Technical Data Packages. The estimates have been obtained from personnel who have been working on the specific functions as well as from budgetary information.

3.5 TRACON Facilities Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in the various options for implementing the output of the E&D program to be kept open until it is possible and timely to make the final implementation decision. This process also



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 3-7
TRACON FACILITIES, TENTATIVE IMPLEMENTATION SCHEDULE

has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in a TRACON facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "Open Items" and "Interface Adjustments."

3.5.1 Open Items

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, and Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the TRACON facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for TRACON facilities. Instead, they might be contained within the program of another interfacing facility. The Open Items pertinent to TRACON facilities are:

Open Item 1: Interface/Integration of Automated Air Traffic Flow Functions

1. Central Flow Control predictions of en route delay would continue to be improved through enhancements in delay forecasting and more data inputs from the en route and terminal ATC facilities, but Central Flow Control (CFC) would not have any automated interface with En Route Metering or ARTS III M&S. The use of Fuel Advisory Departures would be refined to reflect the improved CFC delay predictions.

2. Initial versions of Flight Plan Conflict Probe (FPCP) and En Route Metering would be developed as independent functions. Later versions would be integrated so that the En Route Metering advisories would provide for conflict-free metering instructions. En Route Metering would also be developed to consider efficient ways of absorbing delay to conserve fuel. This will include profile descents, speed changes, path stretching, and holding patterns.

3. The function of Local Flow Control and the concept of providing information specifically tailored for the Local Flow Controller will not be improved upon over and above the improvements that will be associated with en route metering and FPCP.

4. The implementable version of ARTS III Metering and Spacing (M&S) will include flexible control algorithms that will permit profile descents with little or no vectoring during low demand periods and will utilize tighter control procedures with potentially more vectoring during high demand periods. The tighter procedures are

invoked to improve the interarrival spacing at the threshold and thus maintain high runway capacity during high demand periods.

5. An interface will be developed between M&S and terminal area Conflict Alert to provide conflict-free M&S commands.

6. An automated interface will be developed to maximize efficiency of operations between En Route Metering and ARTS III M&S.

Open Item 3: Time Phasing of DABS vs Plans to Use DABS Data Link and Other DABS-Dependent Items

It was implicitly assumed that the FAA will develop a plan for using the DABS data link capability on a schedule that is consistent with the DABS implementation schedule and that the benefits, as perceived by user groups, would result in installation and use of associated avionics.

Open Item 4: Aircraft Separation Assurance

1. The assumption was made that all of the programs aimed at providing automated aids to the pilot and the controller for the avoidance of midair collisions will be successful and will be implemented. These programs include:

a. En Route Conflict Alert.

b. En Route Conflict Resolution advisory function.

c. Terminal Conflict Alert (ARTS III sites).

d. Terminal Conflict Resolution advisory function (ARTS III sites).

e. ATARS (at all DABS sites).

f. BCAS -- "active only" for initial implementation but followed by more sophisticated systems later.

2. It was further assumed that the technical designs of each of the capabilities listed above will be realized within an overall design of an airborne separation assurance system which will assure proper interoperability among the various features and avoid presenting either the pilot or the controller with conflicting instructions or advisories.

Open Item 6: Terminal Area Radars (ASRs)

1. It was assumed that no major changes would be made to improve either aircraft detection or weather detection in the Near Term system (prior to 1982).

2. ASRs (including the new ASR-8s) will be modified to improve both their weather detection and aircraft detection capabilities. Those two modification program will be made sequentially. Aircraft detection will be improved through the addition of an MTD. Later on, the weather detection capability will be improved through the addition of a separate ASR weather channel.

3. As a further step in improving the detection of turbulent weather in the terminal area, the FAA will depend on the use of the joint FAA/NWS/AWS 3D weather radar at those terminal areas where such coverage is available (see Open Item 5). A 3D weather detection capability will be provided at other terminal locations through a further

modification of the ASRs to include pencil beam antennas and pulse doppler processing techniques.

4. The 3D weather detection capability may also provide for the detection of turbulence and low level wind shear under all weather conditions, including clear air.

NOTE: The above implies that the FAA intends to continue to operate primary radars for terminal area surveillance for the foreseeable future.

Open Item 7: Surveillance Data Preprocessors

1. CD-2s will be procured and implemented for the preprocessing of ARSR and ATCRBS en route surveillance data. In the Far Term, these CD-2s will be modified twice: first to accommodate the MTD and later to accommodate an ARSR weather channel. Within a few years, the CDs will be replaced by DABS Processors (July 1984).

2. SRAPs (sometimes referred to as SRAP I) will be procured and implemented for the preprocessing of ASR and ATCRBS terminal area surveillance data. The SRAPs will be located at the ARTS III TRACON facilities. Those same SRAPs will go through two modification programs. The first modification will be to accommodate the addition of MTD to the ASRs. The second modification would come about six months later to accommodate the separate ASR weather channel. Six months later, the modified SRAPs would be replaced by the DABS processors.

Open Item 8: VAS/WVAS Interface/Interaction with ARTS III Metering and Spacing and En Route Metering

1. A manual interface will be established between ARTS M&S, the Vortex Advisory System (VAS) and en route metering that will permit the use of reduced longitudinal separations when the VAS indicates that wake vortex conditions are favorable.

2. As the VAS evolves to a more capable Wake Vortex Avoidance System (WVAS) an automated interface will be implemented between the cited system elements to allow the benefits of further reductions in longitudinal spacing (possibly tailored on an aircraft pair basis) to be operationally realized.

Open Item 10: MLS/ILS/M&S Compatibility

Metering and Spacing algorithms will be refined/modified for use at those locations where it is operationally desirable to accommodate the concurrent use of the conventional straight-in approaches that are flown with guidance by the current Instrument Landing System (ILS) and the more flexible approach geometries that may be flown with guidance by the Microwave Landing System (MLS).

Open Item 12: Terminal/Tower Display and Integration of E&D Products

1. The existing terminal displays for visibility, ceiling, wind, barometric pressure, time, vortex advisories, wind shear, and the status and control monitors for airport communication, navigation, and surveillance systems located in TRACONS and Tower Cabs will be integrated into

an operationally efficient design that uses hardware that also incorporates a remote maintenance and monitoring process capability.

2. Subsequent to the above system improvement, the controller interface equipment located in Tower Cabs at major airports will be sufficiently integrated with proposed new systems to permit an operationally efficient installation of a full complement of new equipment including TIPS, ASDE-3, DABS, Wake Vortex Avoidance Systems, and Advanced Wind Shear Detection Systems.

Open Item 14: Upgrading Terminal Area ATC Facilities (ARTS IIIA, ARTS III, ARTS II, TPX-42)

1. The ARTS III will remain as the primary automation capability at major airports (current ARTS III locations) and will be adequate, with the addition of the ARTS IIIA packages and possibly some augmentation with special purpose computers, to accommodate projected increases in traffic and a full spectrum of ATC improvements including Terminal Metering and Spacing, Terminal Conflict Alert, Terminal Conflict Resolution, Digitized Weather Data, and DABS Data Link.

2. The ARTS II systems will remain as the primary automation capability at the intermediate activity airports currently receiving ARTS II systems. In the absence of specific FAA plans to enhance these systems with improvements such as conflict alert and MSAW, it was assumed that the ARTS II would not be extended beyond the basic capability currently being implemented.

3. The TPX-42 systems at low activity TRACONs and TRACABs will be replaced by either ARTS II or programmable TPX-42 systems in the Far Term (post 1982) time period. Prior to replacement, a limited terrain proximity monitoring function, Low Altitude Alerting System (LAAS), will be implemented.

Open Item 15: Voice Communications Planning

1. Air-ground-air communication for the ARTCCs and major terminals will be upgraded in the post-1982 time period by implementation of the radio portion of VSCS, which would be referred to as RCCS. In the Near Term, RCAG tone control equipment for the ARTCCs will be replaced, possibly with a modular subsystem that would be compatible with longer term RCCS/VSCS designs. The FSSs, which are assumed to remain unconsolidated, will continue to use switching and control equipment based on existing designs. In addition, the transmitters, receivers, and antenna systems at all FAA ground sites will be replaced with modern design equipment.

2. Ground-ground communications would be modernized by the implementation of ground-ground portions of the VSCS system which would replace the WECO 300 system at ARTCCs, and the WECO 301 system at the larger terminals. The existing small key systems and call distributors at FSSs would remain in place.

3. At some smaller terminals a Small Voice Switching System (SVSS) will be implemented, which will provide an integrated radio and ground voice communications capability.

Open Item 17: Display of Digitized Surveillance at TRACONs and Towers

1. ASRs will be modified in the early 1980s to include an ASR weather channel for weather detection and processing and a Moving Target Detector for enhanced aircraft detection. This means that weather and aircraft surveillance information will be in the form of digitized data.

2. All-digital displays will be available at ARTS III sites on a schedule that is compatible with displaying the digitized weather and aircraft data starting in the early 1980s.

3. No expansion of the digital display capability at the ARTS II and TPX-42 locations will be available.

Open Item 18: Detection of Turbulence and Low Level Wind Shear

1. No Major improvements will be made in the detection of hazardous weather in the Near Term ATC system configuration (i.e., no major improvements implemented prior to 1982 with the exception of the Low Level Wind Shear Alert System (LLWSAS)).

2. The first major improvement will start to be implemented in the early part of the Far Term system (1984). The first major improvement will be achieved by modifying both the ARSRs and the ASRs to include what is referred to as a separate weather channel. The separate weather channel is likely to include an MTD capability for the special processing of the returns from precipitation to indicate areas of heavy precipitation. In order to achieve this capability, all ARSRs and ASRs will be modified or replaced. In the

case of both the ARSRs and the ASRs, the weather data will be two-dimensional (range and azimuth).

3. The second major improvement will be realized by adding the 3D weather detection capability, i.e., range, azimuth, and altitude of turbulence and low level wind shear. For the en route system, the 3D capability will be realized through a joint FAA/NWS/AWS program to develop and implement a Joint Use Weather Radar. For the terminal area system, the 3D capability will be realized either through a further modification to the ASRs to provide a 3D capability and/or through inputs from the Joint Use radars for those terminal areas where coverage from the Joint Use radars satisfy the terminal control requirements for detecting low level wind shear as well as turbulence.

4. The 3D weather detection system for the terminal area will include the capability of detecting and analyzing turbulence and wind shear in clear air as well as under conditions where precipitation is present.

Open Item 19: Weather Data Dissemination

A Center Weather Service Unit (CWSU) will be implemented at each ARTCC and will receive, interpret, coordinate, and dispatch graphic and tabular weather data to controller operating positions within the ARTCC and in associated TRACONs. The distribution of weather data to controller positions will be accomplished by TIPS for Towers/TRACONs and will be accomplished by ETABS for ARTCCs. In light of incomplete FAA plans for accomplishing the distribution

of graphical weather data to controller positions, the specific devices used for distribution were not designated in this document.

Open Item 20: Remote Maintenance and Monitoring

1. Integrated remote maintenance and monitoring functions will be incorporated into the RCAG, en route surveillance, VORTAC and airport facilities for navigation, communications, and surveillance. The Remote Maintenance Monitor System (RMMS) capabilities consist of equipment monitoring and fault alarming, remote certification, automated record keeping, trend analysis and remote control of redundant units and some facility functions.

2. The RMMS at airport facilities would utilize a special processor to be located in the associated tower/TRACON. For other facilities, the RMMS will utilize a dedicated processor located at each ARTCC. All maintenance information will be transmitted from the cited facilities via existing communication links to the processor for storage, processing, and access by technicians using special common terminals located either local to the ARTCC or at remote locations. No assumptions were made regarding how the RMMS data would be provided and displayed to the responsible technicians since FAA plans have yet to be made in these areas.

3. The DABS and MLS systems to be installed in the Far Term will also incorporate RMMS functions that are compatible with the above concept.

3.5.2 Interface Adjustments

This section identifies some fairly specific smaller scale interface uncertainties. These uncertainties generally involve minor design modifications in one or more programs that are not considered as significant as the previously cited Open Items. The Interface Adjustments pertinent to the TRACON Facilities chapter are:

Interface Adjustment B2-1 -- Exchange of Conflict Alert Information Between Facilities

A Controller Alert or Conflict Resolution Advisory will sometimes be displayed at the En Route facility but not at the nearby TRACON, or vice versa. For aircraft that are at, or near, the boundaries between En Route and Terminal areas, conflict information generated by either facility should be displayed at appropriate sectors in both facilities.

Interface Adjustment B3-1 -- Three-Dimensional Weather Interface with ARTS III

In the Far Term, digitized weather data will be provided to ARTS III sites. The data will have altitudes associated with it, and thus will be three-dimensional. Conceptual and experimental work should be performed to make certain that the weather data will be displayed in a manner that will make it most useful to controllers.

Interface Adjustment B3-2 -- Terminal and En Route Conflict Alert and Conflict Resolution Advisory Algorithms

Differences in Conflict Alert and Conflict Resolution Advisory algorithms between terminal and en route systems

will cause false alerts, no alerts, late alerts, or different recommended maneuvers for one facility in relation to another. Investigation should be made of the feasibility of adjusting the algorithms for aircraft that are near boundaries between En Route and Terminal areas so as to provide consistent results that are not confusing to controllers.

4. TOWER FACILITIES

This chapter describes the ATC facilities that control most of the aircraft operating within an airport traffic area, i.e., within 5 miles of an airport and below 3000 feet AGL, or taxiing on the ground. Functions performed in a Tower Cab relating to terminal area traffic control outside the airport traffic area were discussed previously in Chapter 3 and will not be repeated.

In Section 4.1, the current functions and equipment at different types of Tower Cabs are discussed in a general manner and the near term and far term improvements are summarized. Then, a more detailed discussion of the anticipated functional and connectivity changes associated with these Tower Cab improvements is given in Sections 4.2 and 4.3. This, in turn, is followed by a discussion of the tentative implementation schedule for the improvements in Section 4.4. Section 4.5 summarizes the major assumptions that were made with regard either to interfaces with other ATC facilities or the time phasing of the various tower improvements.

4.1 Tower Cab Improvements Summary

Table 4-1 illustrates the four major types of airports and their associated air traffic control facilties.

- The High IFR Activity Airports have a large amount of air traffic that operate in accordance with an IFR flight plan and a relatively small amount of VFR traffic. Currently, about 75% of all air carrier operations take place at this type of airport.

TABLE 4-1
CURRENT TERMINAL ATC FACILITIES

	AIRPORT TYPE	TRACON	TRACAB	TOWER CAB
	HIGH IFR ACTIVITY AIRPORTS (67)	ARTS III AUTOMATION (63)	NONE	67 AIRPORTS *
	MEDIUM IFR ACTIVITY AIRPORTS (112)	ARTS II OR AN/TPX-42 AUTOMATION (73) (39)		112 AIRPORTS
LOW IFR ACTIVITY AIRPORTS	HIGH VFR ACTIVITY AIRPORTS (222)	NONE	NONE	222 AIRPORTS
LOW IFR ACTIVITY AIRPORTS	MEDIUM AND LOW VFR ACTIVITY AIRPORTS (10,000+)	NONE	NONE	NONE

*SEVERAL OF THE HIGH IFR ACTIVITY AIRPORTS SHARE A COMMON TRACON, e.g., JFK, NEWARK, AND LA GUARDIA IN NEW YORK CITY.

- The Medium IFR Activity Airports have a higher level of VFR traffic and less IFR traffic than the high IFR activity airports and, in general, less total annual activity. Most of the remaining air carrier operations take place at this type of airport.

- The High VFR Activity Airports have a large amount of VFR traffic and very little IFR traffic. Almost all of the traffic at these airports is small general aviation aircraft.

- The Medium and Low VFR Activity Airports have less VFR traffic and do not have a Tower Cab. While most airports are of this type, the annual activity at these airports is usually very low. In fact, less than half of these airports have either paved runways or runway lights.

Table 4-2 lists the current functions and equipment associated with a Tower Cab at a given type of airport. Not surprisingly, while the functions performed at all Tower Cabs are similar, the highest level of equipment exists at the high IFR activity airports. All of the other airport types have a subset of this equipment.

The control of most traffic within the airport traffic area is performed by air traffic controllers in the Tower Cab. Visual surveillance of the aircraft under control is normally used whenever possible. However, when aircraft are beyond visual range or the visibility is restricted due to the weather or time of day, then the controllers utilize the ASR/ATCBI BRITE Display for surveillance information. Voice communications

TABLE 4-2
CURRENT TOWER CAB FUNCTIONS AND EQUIPMENT

FUNCTIONS	HIGH IFR ACTIVITY AIRPORT	MEDIUM IFR ACTIVITY AIRPORT	HIGH VFR ACTIVITY AIRPORT
1. AIRPORT TRAFFIC AREA CONTROL	ASR/ATCBI BRITE	ASR/ATCBI BRITE	NONE
2. RUNWAY AND TAXIWAY CONTROL	ASDE-2	NONE	NONE
3. FLIGHT DATA HANDLING	FDEP	FDEP	FDEP
4. WEATHER DATA GATHERING	WEATHER SENSORS	WEATHER SENSORS	WEATHER SENSORS
5. AIRPORT, WEATHER DATA DISSEMINATION	ATIS	ATIS	NONE
6. AIRPORT LIGHTING CONTROL	AIRPORT LIGHTS	AIRPORT LIGHTS	AIRPORT LIGHTS

between the controllers and the aircraft is accomplished by VHF or UHF radio.(1)

Similarly, visual surveillance of aircraft taxiing on the ground is augmented at some high IFR activity airports by an ASDE-2 BRITE Display.

Flight plan data on arriving aircraft is forwarded from the ARTCC to the Tower Cab and printed out on the Flight Data Entry and Printout (FDEP) equipment, and messages on departing aircraft are sent from the Tower Cab to the ARTCC via FDEP.

Weather information, including data on the wind, barometric pressure, temperature, ceiling, and visibility, is periodically gathered at the airport either by personnel in the Tower Cab or at associated Flight Service Stations or National Weather Service (NWS) offices and forwarded to other ATC and NWS facilities. In addition, during periods of rapid change in the weather, special observations are made.

Information on the weather and the status of the airport's navigation aids and runways is forwarded to aircraft operating in the terminal area either automatically through continuously broadcasted Automatic Terminal Information System (ATIS) messages pre-recorded in the Tower Cab, or by the air traffic controllers.

Air traffic controllers in the Tower Cab are also responsible for adjusting the intensity of the approach, runway, and taxiway lighting systems to optimize their performance under the current visibility conditions at the airport.

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(1) Civilian aircraft utilize VHF voice communications and military aircraft utilize VHF or UHF voice communications.

Having briefly described the functions performed at a current Tower Cab, an overview of the Near Term and Far Term improvements at each airport type, as shown in Table 4-3, will now be presented.

In the Near Term (1979-1982), two significant improvements are anticipated.

- The installation of the Vortex Advisory System (VAS) at some high IFR activity airports to measure the wind direction and velocity along the approach path and thereby allow a reduction in the longitudinal separation between arriving aircraft under the appropriate wind conditions.
- The installation of the Low Level Wind Shear Alert System (LLWSAS) at most high IFR activity airports to detect sudden changes in the wind conditions in the vicinity of an airport due to updrafts and downdrafts and thus alert the air traffic controllers about the presence of a hazardous wind shear condition.

In the Far Term (post-1982), twelve significant improvements are tentatively being considered by the FAA.

- The evolution from VAS to the Wake Vortex Avoidance System (WVAS) which would detect the presence of wake vortices and thereby allow for an even greater reduction in the longitudinal separation between arriving aircraft.

TABLE 4-3
TOWER CAB IMPROVEMENTS

	FUNCTIONS	CURRENT SYSTEM (1978)	NEAR TERM IMPROVEMENTS (1979-1982)	FAR TERM IMPROVEMENTS (POST-1982)
HIGH IFR ACTIVITY AIRPORTS	1. AIRPORT TRAFFIC AREA CONTROL	NA ASR/ATCBI BRITE	VAS* NC	WVAS TCDD
	2. RUNWAY AND TAXIWAY CONTROL	ASDE-2	NC	ASDE-3, TAGS,VICON
	3. FLIGHT PLAN HANDLING	FDEP	NC	TIPS
	4. WEATHER DATA GATHERING	NA WEATHER SENSORS	LLWSAS* NC	AWSDS ACD, RMMS
MEDIUM IFR ACTIVITY AIRPORTS	2. RUNWAY AND TAXIWAY CONTROL	NA	NA	VICON
	3. FLIGHT PLAN HANDLING	FDEP	NC	TIPS
	4. WEATHER DATA GATHERING	WEATHER SENSORS	NC	ACD, RMMS
HIGH VFR ACTIVITY AIRPORTS	2. RUNWAY AND TAXIWAY CONTROL	NA	NA	VICON
	3. FLIGHT PLAN HANDING	FDEP	NC	TIPS
	4. WEATHER DATA GATHERING	WEATHER SENSORS	NC	SAMOS
MEDIUM VFR ACTIVITY AIRPORTS	5. WEATHER DATA DISSEMINATION	NA	NA	ALWOS, WAVE

NA = NOT APPLICABLE
NC = NO CHANGE INCLUDED IN CURRENT PLANS
* = APPROVED BY THE FAA FOR IMPLEMENTATION

- The replacement of the existing analog ASR/ATCBI BRITE Displays at high IFR activity airports with Tower Cab Digital Displays (TCDDs) to improve the display presentation.

- The replacement of all vacuum tube ASDE-2s with solid state ASDE-3s with an improved surveillance display, and the installation of ASDE-3s at some high IFR activity airports that do not currently have an ASDE.

- The installation of a Tower Automated Ground Surveillance (TAGS) System at a few high IFR activity airports to add alphanumeric flight information to the ASDE-3 Display.

- The installation of a Visual Confirmation of Voice Takeoff Clearance (VICON) system at most airports with a control tower to visually confirm to the pilot the controller's takeoff clearance.

- The replacement of FDEP equipment with Terminal Information Processing Systems (TIPSs) at airports with a control tower to speed up the flow of flight plan and weather data, and to eliminate the need for flight progress strips by utilizing electronic tabular displays.

- The replacement of the LLWSAS system with the Advanced Wind Shear Detection System (AWSDS) which would directly measure the wind shear along the approach path and thus detect both horizontal and vertical wind shear.

- The installation of an ATCT (Airport Traffic Control Tower) Consolidated Displays (ACDs) at medium and high IFR activity airports to consolidate the individual airport weather sensor indicators and the status information on the various airport communications, surveillance, and navigation facilities. In addition, wind shear and wake vortex data would be added to each display at the airports equipped with these sensors.

- The installation of ATCT (Airport Traffic Control high IFR activity airports to process the data for the consolidated display, and to provide information on the status of the airport communications, surveillance, and navigation facilities for FAA maintenance personnel as part of the Remote Maintenance Monitor System (RMSS) - see Chapter 2 for a discussion of RMMS.

- The installation of Semi-Automated Meteorological Observation Systems (SAMOSs) at some high VFR activity airports to aid the controllers by automatically taking some weather observations and distributing this data to other ATC and NWS facilities via NADIN.

- The installation of Automated Low-Cost Weather Observation Systems (ALWOSs) at some medium VFR activity airports to provide weather data via an automatic VOR voice broadcast to pilots executing an instrument approach, and to provide weather data to some ATC and NWS facilities via NADIN.

- The installation of Wind and Altimeter Voice Equipment (WAVE) systems at some medium VFR activity airports to provide wind and altimeter setting data via an automatic VOR voice broadcast to pilots executing an instrument approach. The WAVE system is a subset of the equipment used in ALWOS.

Beyond these anticipated Far Term improvements, the FAA is tentatively exploring two other improvements:

- The possible utilization of Automated Terminal Service (ATS) systems to provide air traffic control services at a few medium VFR activity airports without a Tower Cab. ATS would consist of a surveillance system (either ATCRBS or DABS) and an ATS Processor. The ATS Processor would digitally process the surveillance data and issue advisories to arriving and departing aircraft either by computer generated voice messages or a DABS data link. The advisories would be used to improve aircraft safety in the vicinity of the airport at a lower cost than the installation of a Tower Cab.

- The possible utilization of an Airborne Wind Shear System (AWSS) to alert the pilot to the presence of wind shear during takeoffs and landings. There are several possible airborne methods of detecting wind shear. The most promising method uses an analog display which shows aircraft ground speed versus indicated airspeed. With this information,

the pilot could detect the presence of wind shear and adjust his airspeed to compensate for its effects.

4.2 Tower Cab System Connectivity

Figures 4-1, 4-2, and 4-3 illustrate the current connections between a Tower Cab and the other ATC facilities and the changes in these connections due to the anticipated Near Term and Far Term improvements.

Two significant changes in connectivity will occur when the Near Term improvements are implemented.

- The installation of the LLWSAS will mean that wind data will be sent from the LLWSAS Sensors to the LLWSAS Processor in the tower[1], and wind shear information will be sent from the Tower Cab to the TRACON by voice communications.
- Similarly, the installation of VAS will mean that wind data will be sent from the VAS Sensors to the VAS Processor in the tower, and longitudinal separation criteria will be sent from the VAS Processor in the tower to the TRACON.

In the Far Term, seven additional changes in connectivity may be made.

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(1) The LLWSAS, VAS, TIPS, etc. systems will require processors which will be located somewhere in the tower but not necessarily in the Tower Cab. For simplicity, it has been assumed in the connectivity diagrams that these processors are located in the Tower Cab.

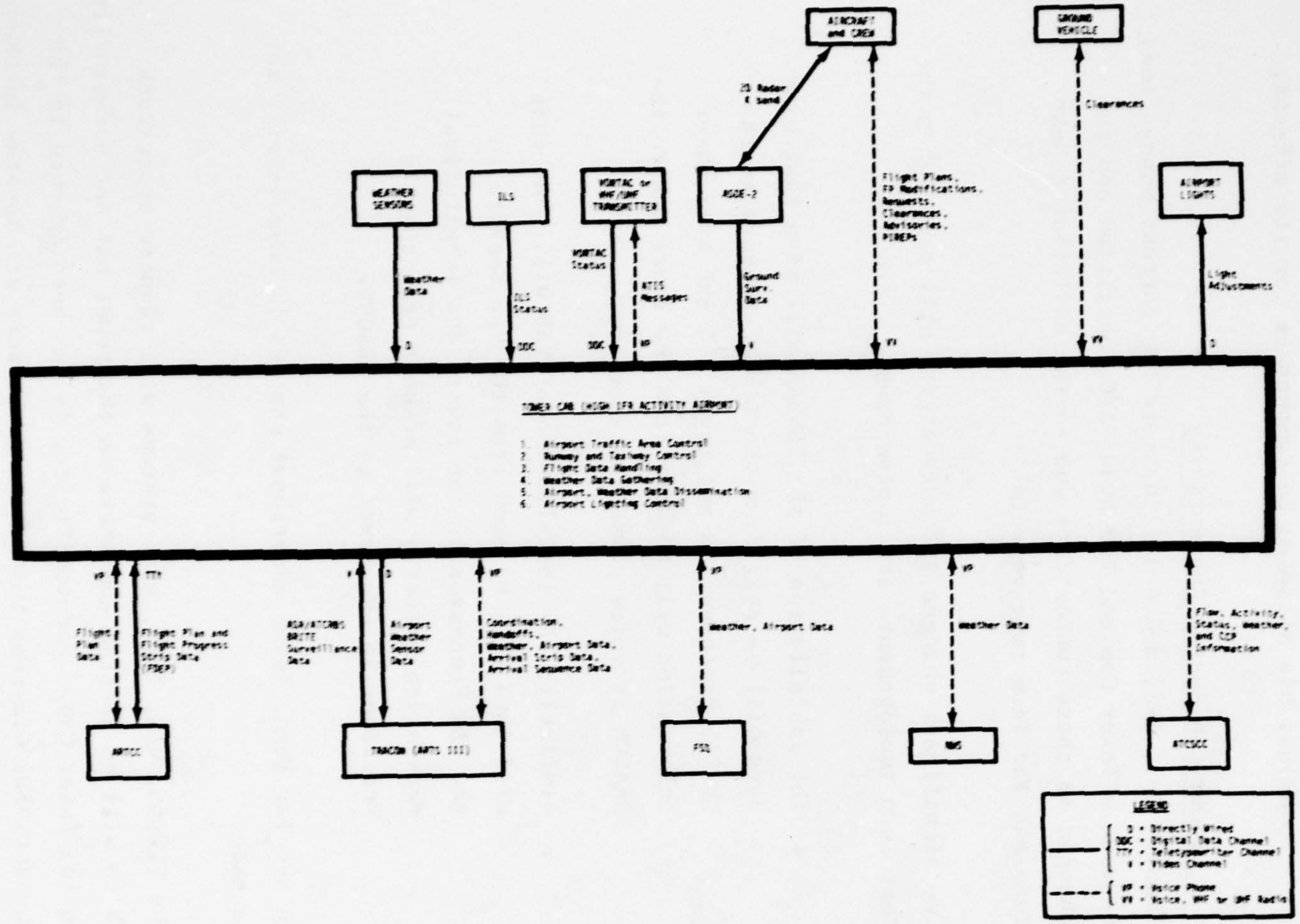


FIGURE 4-1
CURRENT TOWER CAB CONNECTIVITY DIAGRAM
(HIGH IFR ACTIVITY AIRPORT)

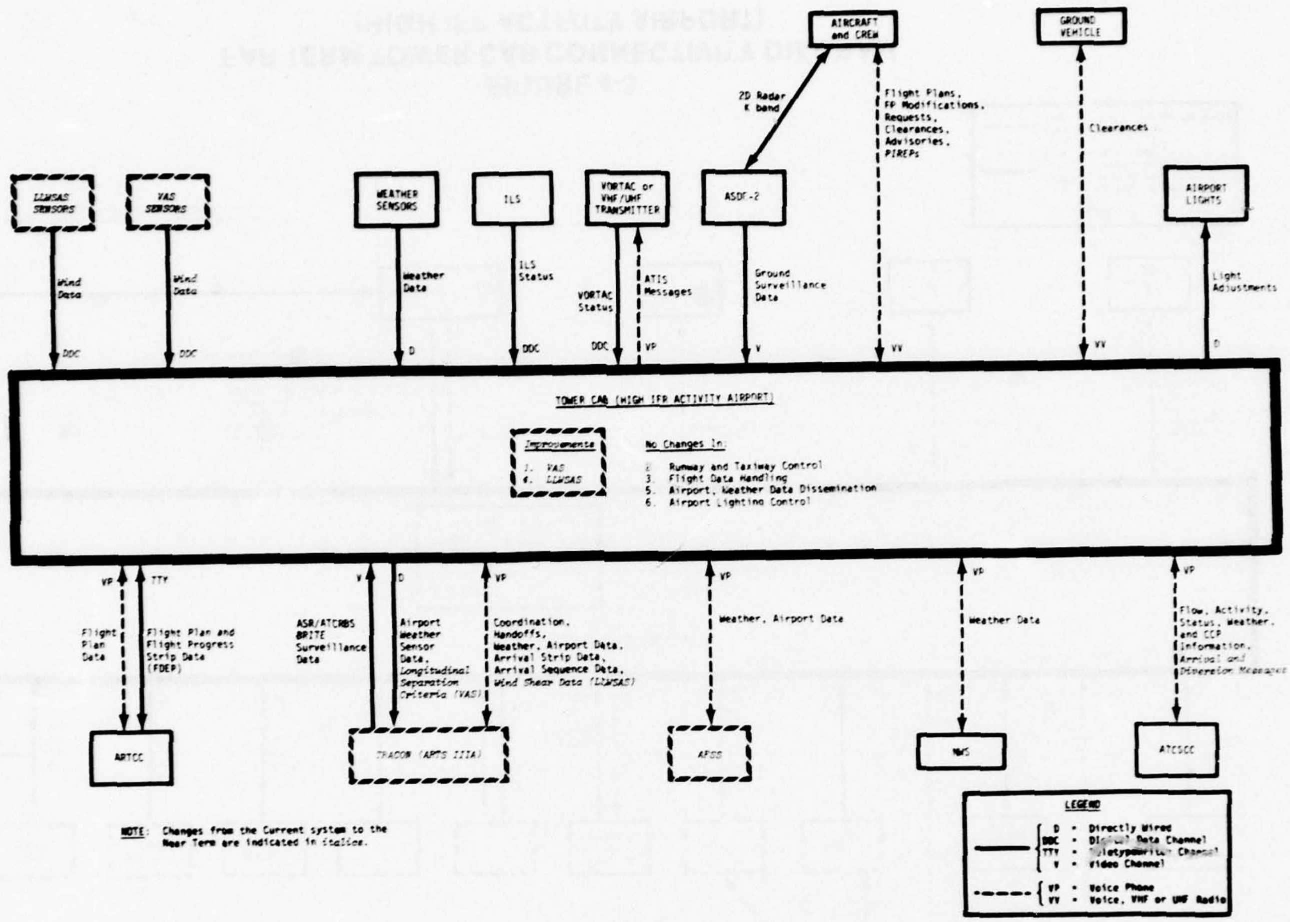


FIGURE 4-2
NEAR TERM TOWER CAB CONNECTIVITY DIAGRAM
(HIGH IFR ACTIVITY AIRPORT)

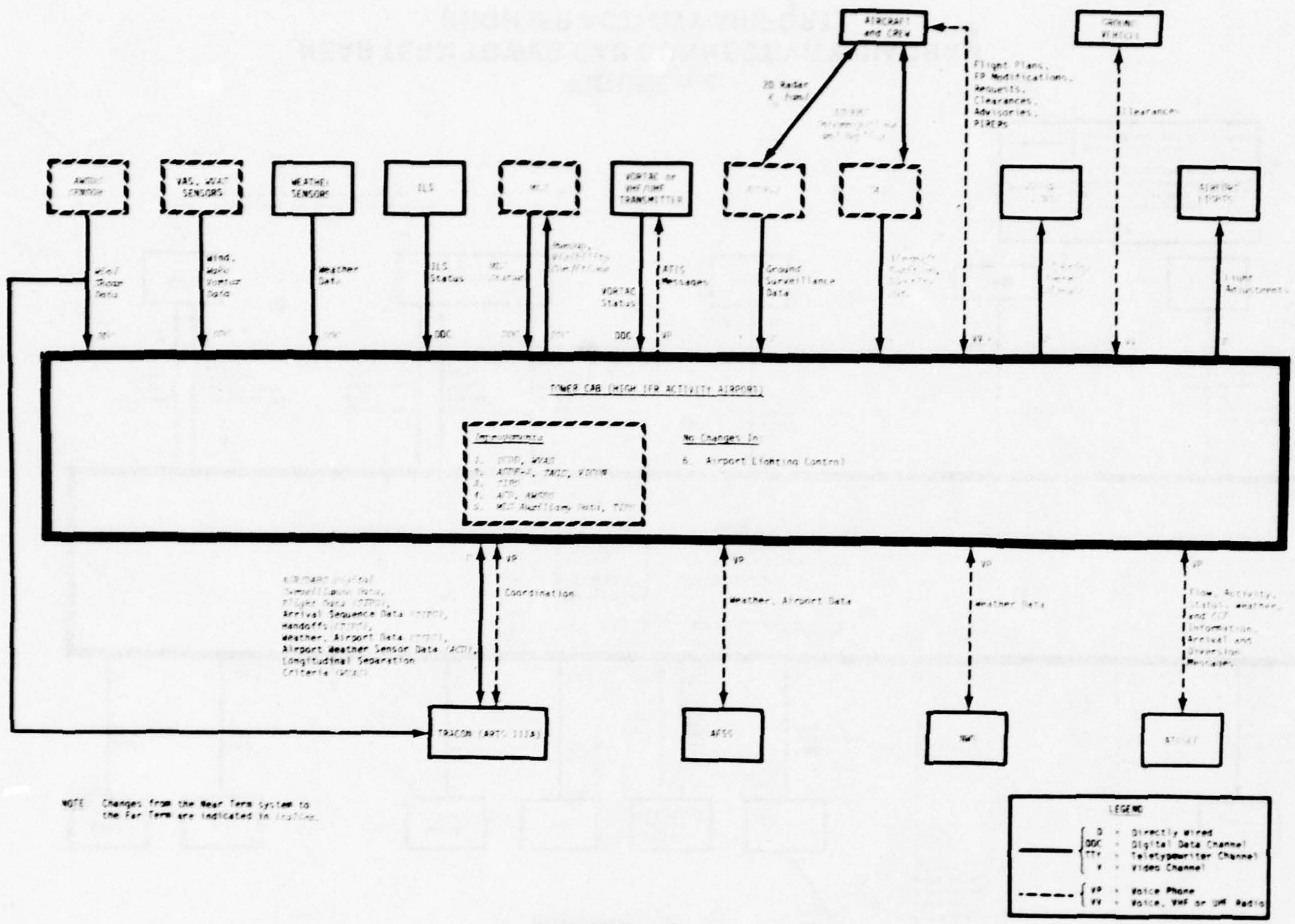


FIGURE 4-3
FAR TERM TOWER CAB CONNECTIVITY DIAGRAM
(HIGH IFR ACTIVITY AIRPORT)

- The replacement of the LLWSAS with the AWSDS would mean that wind shear data, instead of surface wind data, would be sent to the tower. Wind shear data may also be sent directly from the AWSDS Sensor to the TRACON if the sensor is the Joint Use Weather Radar (see Chapter 7 for a discussion of the Joint Use Weather Radar).

- The installation of WVAS would mean that wake vortex data, in addition to wind data, would be sent to the tower.

- The installation of Microwave Landing Systems (MLSs) with an automatic landing (autoland) capability would require that the Tower Cab furnish the MLS with information on runway conditions and visibility. The MLS, in turn, would send this data along with MLS siting data and current MLS status data to the approaching aircraft via an MLS digital uplink (see Chapter 8 for a discussion of MLS).

- The replacement of FDEP with TIPS would mean that flight plan data would be exchanged with the ARTCC through the TRACON, rather than directly with the ARTCC. Other data, previously sent by voice between the Tower Cab and the TRACON, would now be exchanged through TIPS.

- The installation of TAGS at a few high IFR activity airports would mean that aircraft identity and position information would be sent from the TAGS beacon interrogators to the Tower Cab.

- The installation of VICON at most airports with a control tower would mean that VICON lighting control signals would be sent from the Tower Cab to the VICON lights located at all runway departure points.
- The installation of the TCDD would mean that digital surveillance data instead of video data would be sent to the Tower Cab from the TRACON.

4.3 Tower Cab Information Flow

This section utilizes Figures 4-4, 4-5, and 4-6 to describe in more detail the impact of the Near Term and Far Term improvements, briefly summarized in Section 4.1, on the external information flow and the internal functions performed at each Tower Cab.

4.3.1 Near Term Improvements

There are two significant Near Term improvements which would impact the external information flow or the internal functions performed at a Tower Cab located at a high IFR activity airport.

1. Vortex Advisory System (VAS)

As shown in Figure 4-7, aircraft in flight generate counter-rotating wake vortices that trail from their wing tips. Since the strength of these vortices is directly related to the weight of the aircraft, the utilization of large wide body jet aircraft in recent years has created a potential safety problem in the vicinity of airports where aircraft follow other aircraft at relatively close distances. The FAA has temporarily solved this problem by adopting greater longtudinal separation (3 to 6 nautical miles) between arriving aircraft as a fucntion of aircraft type.

INPUTS

FROM WEATHER SENSORS

- WIND, PRESSURE, TEMPERATURE, CEILING, AND VISIBILITY DATA

FROM TRACON

- COORDINATION
- ARRIVAL SEQUENCE DATA AND ARRIVAL FLIGHT PROGRESS STRIP DATA
- HANDOFFS
- WEATHER DATA
- ASR/ATCRBS SURVEILLANCE DATA

FROM ARTCC

- FLIGHT PLAN AND FLIGHT PROGRESS STRIP DATA (FDEP)

FROM ASDE-2

- BROADBAND (VIDEO) AIRCRAFT RETURNS (RANGE, AZIMUTH)

FROM AIRCRAFT (AIR CREW)

- FLIGHT PLANS, REQUESTS FOR FP CHANGES
- REQUESTS FOR CLEARANCES
- PIREPS
- REQUESTS FOR INFORMATION
- PROGRESS REPORTS

FROM GROUND VEHICLES

- REQUESTS FOR CLEARANCES

FROM FLIGHT SERVICE STATION (FSS) OR NATIONAL WEATHER SERVICE (NWS)

- WEATHER DATA

FROM ATCSCC

- REQUESTS FOR SITUATION REPORTS
- ARRIVAL AND DEPARTURE DELAY PREDICTIONS
- ASSISTANCE IN HANDLING CALAMITIES OR IMPENDING CALAMITIES

FUNCTIONS

1. AIRPORT TRAFFIC AREA CONTROL (ASR/ATCBI BRITE)
   - ISSUE TAKEOFF AND LANDING CLEARANCES
   - MAINTAIN SAFE SEPARATION DISTANCES BETWEEN AIRCRAFT
   - EMERGENCY ASSISTANCE
2. RUNWAY AND TAXIWAY CONTROL (ASDE-2)
   - ISSUE COMMANDS TO TAXIING AIRCRAFT
   - CONTROL GROUND VEHICLES ON RUNWAYS AND TAXIWAYS
3. FLIGHT DATA HANDLING (FDEP)
   - RECEIVE FLIGHT DATA FROM ARTCC
   - DELIVER INSTRUMENT CLEARANCES TO DEPARTING AIRCRAFT
4. WEATHER DATA GATHERING (WEATHER SENSORS)
   - RECORD HOURLY SURFACE WEATHER DATA
   - RECORD AIRPORT VISIBILITY DATA
   - REQUESTS PIREPS
5. AIRPORT, WEATHER DATA DISSEMINATION (ATIS)
   - RECORD AND FORWARD AIRPORT, WEATHER DATA
6. AIRPORT LIGHTING CONTROL
   - CONTROL APPROACH, RUNWAY AND TAXIWAY LIGHTS

OUTPUTS

TO TRACON

- COORDINATION
- HANDOFFS
- WEATHER AND AIRPORT DATA
- AIRPORT WEATHER SENSOR DATA

TO ARTCC

- FLIGHT PLAN DATA (FDEP)

TO VORTAC OR VHF/UHF TRANSMITTER

- RECORDED ATIS MESSAGE (AIRPORT, WEATHER DATA)

TO AIRCRAFT (AIR CREW)

- CLEARANCE
- FP MODIFICATION
- INSTRUCTIONS, ADVISORIES
- REQUESTS FOR PIREPS

TO GROUND VEHICLES

- CLEARANCES
- INSTRUCTIONS, ADVISORIES

TO FLIGHT SERVICE STATION (FSS)

- WEATHER, AIRPORT DATA

TO NATIONAL WEATHER SERVICE (NWS)

- WEATHER DATA

TO AIRPORT LIGHTS

- ADJUSTMENTS FOR APPROACH, RUNWAY AND TAXIWAY LIGHT INTENSITY

TO ATCSCC

- SITUATION REPORTS
- REQUESTS FOR ASSISTANCE IN HANDLING CALAMITIES OR IMPENDING CALAMITIES

FIGURE 4-4
CURRENT TOWER CAB FUNCTIONS
(HIGH IFR ACTIVITY AIRPORTS)
FUNCTIONAL INFORMATION FLOW DIAGRAM

INPUTS

FROM WEATHER SENSORS

- WIND, PRESSURE, TEMPERATURE, CEILING, AND VISIBILITY DATA

FROM TRACON

- COORDINATION
- ARRIVAL SEQUENCE DATA AND ARRIVAL FLIGHT PROGRESS STRIP DATA
- HANDOFFS
- WEATHER DATA
- ASR/ATCRBS SURVEILLANCE DATA

FROM ARTCC

- FLIGHT PLAN AND FLIGHT PROGRESS STRIP DATA (FDEP)

FROM ASDE-2

- BROADBAND (VIDEO) AIRCRAFT RETURNS (RANGE, AZIMUTH)

FROM LLWSAS SENSORS

- *WIND DATA*

FROM VAS SENSORS

- *WIND DATA*

FROM *AIRCRAFT (AIR CREW)*

- FLIGHT PLANS, REQUESTS FOR FP CHANGES
- REQUESTS FOR CLEARANCES
- PIREPS
- REQUESTS FOR INFORMATION
- PROGRESS REPORTS

FROM GROUND VEHICLES

- REQUESTS FOR CLEARANCES

FROM *AUTOMATED FLIGHT SERVICE STATION (AFSS)* OR NATIONAL WEATHER SERVICE (NWS)

- WEATHER

FROM ATCSCC

- REQUESTS FOR SITUATION REPORT
- ARRIVAL AND DEPARTURE DELAY PREDICTIONS
- ASSISTANCE IN HANDLING CALAMITIES OR IMPENDING CALAMITIES

FUNCTIONS

1. AIRPORT TRAFFIC AREA CONTROL (ASR/ATCBI BRITE)
   - ISSUE TAKEOFF AND LANDING CLEARANCES
   - MAINTAIN SAFE SEPARATION DISTANCES BETWEEN AIRCRAFT *(VAS)*
   - EMERGENCY ASSISTANCE
2. RUNWAY AND TAXIWAY CONTROL (ASDE-2)
   - ISSUE COMMANDS TO TAXIING AIRCRAFT
   - CONTROL GROUND VEHICLES ON RUNWAYS AND TAXIWAYS
3. FLIGHT DATA HANDLING (FDEP)
   - RECEIVE FLIGHT DATA FROM ARTCC
   - DELIVER INSTRUMENT CLEARANCES TO DEPARTING AIRCRAFT
4. WEATHER DATA GATHERING (WEATHER SENSORS)
   - RECORD HOURLY SURFACE WEATHER DATA
   - RECORD AIRPORT VISIBILITY DATA
   - REQUEST PIREPS
   - MONITOR WIND SHEAR *(LLWSAS)*
5. AIRPORT, WEATHER DATA DISSEMINATION *(ATIS)*
   - RECORD AND FORWARD AIRPORT, WEATHER DATA
6. AIRPORT LIGHTING CONTROL
   - CONTROL APPROACH, RUNWAY AND TAXIWAY LIGHTS

OUTPUTS

TO TRACON

- COORDINATION
- HANDOFFS
- WEATHER AND AIRPORT DATA
- AIRPORT WEATHER SENSOR DATA
- *LONGITUDINAL SEPARATION CRITERIA (VAS)*
- *WIND SHEAR DATA (LLWSAS)*

TO ARTCC

- FLIGHT PLAN DATA (FDEP)

TO VORTAC OR VHF/UHF TRANSMITTER

- RECORDED ATIS MESSAGE (AIRPORT, WEATHER DATA)

TO AIRCRAFT (AIR CREW)

- CLEARANCES
- FP MODIFICATION
- INSTRUCTIONS, ADVISORIES
- REQUESTS FOR PIREPS

TO GROUND VEHICLES

- CLEARANCES
- INSTRUCTIONS, ADVISORIES

TO *AUTOMATED FLIGHT SERVICE STATIONS (AFSS)*

- WEATHER, AIRPORT DATA

TO NATIONAL WEATHER SERVICE (NWS)

- WEATHER DATA

TO AIRPORT LIGHTS

- ADJUSTMENTS FOR APPROACH, RUNWAY AND TAXIWAY LIGHT INTENSITY

TO ATCSCC

- SITUATION REPORTS
- REQUESTS FOR ASSISTANCE IN HANDLING CALAMITIES OR IMPENDING CALAMITIES
- *ARRIVAL AND DIVERSION MESSAGES*

FIGURE 4-5
NEAR TERM TOWER CAB FACILITIES
(HIGH IFR ACTIVITY AIRPORTS)
FUNCTIONAL INFORMATION FLOW DIAGRAM

INPUTS

FROM WEATHER SENSORS

- WIND, PRESSURE, TEMPERATURE, CEILING, AND VISIBILITY DATA

FROM TRACON

- COORDINATION
- ARRIVAL SEQUENCE DATA AND FLIGHT DATA *(TIPS)*
- HANDOFFS *(TIPS)*
- WEATHER DATA *(TIPS)*
- ASR/*DABS DIGITAL* SURVEILLANCE DATA

FROM *ASDE-3/TAGS*

- BROADBAND (VIDEO) AIRCRAFT RETURNS (RANGE, AZIMUTH, *IDENTITY*)

FROM AWSDS SENSOR

- *WIND SHEAR DATA*

FROM WVAS SENSOR

- *WAKE VORTEX DATA*

FROM VAS SENSORS

- WIND DATA

FROM AIRCRAFT (AIR CREW)

- FLIGHT PLANS, REQUESTS FOR FP CHANGES
- REQUESTS FOR CLEARANCES
- PIREPS
- REQUESTS FOR INFORMATION
- PROGRESS REPORTS

FROM GROUND VEHICLES

- REQUESTS FOR CLEARANCES

FROM AFSS OR NWS

- WEATHER DATA

FUNCTIONS

1. AIRPORT TRAFFIC AREA CONTROL *(TCDD)*
   - ISSUE TAKEOFF AND LANDING CLEARANCES
   - MAINTAIN SAFE SEPARATION DISTANCES BETWEEN AIRCRAFT *(WVAS)*
   - EMERGENCY ASSISTANCE
2. RUNWAY AND TAXIWAY CONTROL *(ASDE-3* WITH *TAGS, VICON)*
   - ISSUE COMMANDS TO TAXIING AIRCRAFT
   - CONTROL GROUND VEHICLES ON RUNWAYS AND TAXIWAYS
3. FLIGHT DATA HANDLING *(TIPS)*
   - RECEIVE FLIGHT DATA FROM TRACON
   - DELIVER INSTRUMENT CLEARANCES TO DEPARTING AIRCRAFT
4. WEATHER DATA GATHERING (WEATHER SENSORS)
   - RECORD HOURLY SURFACE WEATHER DATA *(ACD)*
   - RECORD AIRPORT VISIBILITY DATA *(ACD)*
   - REQUEST PIREPS
   - MONITOR WIND SHEAR *(AWSDS)*
5. AIRPORT, WEATHER DATA DISSEMINATION (ATIS, *MLS AUXILLIARY DATA)*
   - RECORD AND FORWARD AIRPORT, WEATHER DATA
6. AIRPORT LIGHTING CONTROL
   - CONTROL APPROACH, RUNWAY AND TAXIWAY LIGHTS

OUTPUTS

TO TRACON

- COORDINATION
- HANDOFFS *(TIPS)*
- WEATHER, AIRPORT DATA *(TIPS)*
- AIRPORT WEATHER SENSOR DATA
- *LONGITUDINAL SEPARATION CRITERIA (WVAS)*
- WIND SHEAR DATA *(AWSDS)*

TO VORTAC OR VHF/UHF TRANSMITTER

- RECORDED ATIS MESSAGE (AIRPORT, WEATHER DATA)

TO AIRCRAFT (AIR CREW)

- CLEARANCES
- FP MODIFICATIONS
- INSTRUCTIONS, ADVISORIES
- REQUESTS FOR PIREPS

TO MLS

- *MLS AUXILIARY DATA (RUNWAY, VISIBILITY CONDITIONS)*

TO GROUND VEHICLES

- CLEARANCES
- INSTRUCTIONS, ADVISORIES

TO AUTOMATED FLIGHT SERVICE STATION (AFSS)

- WEATHER, AIRPORT DATA

TO NATIONAL WEATHER SERVICE (NWS)

- WEATHER DATA

TO AIRPORT LIGHTS

- ADJUSTMENTS FOR APPROACH, RUNWAY AND TAXIWAY LIGHT INTENSITY

TO VICON LIGHTS

- *LIGHTING CONTROL SIGNALS*

FIGURE 4-6
FAR TERM TOWER CAB FACILITIES
(HIGH IFR ACTIVITY AIRPORTS)
FUNCTIONAL INFORMATION FLOW DIAGRAM

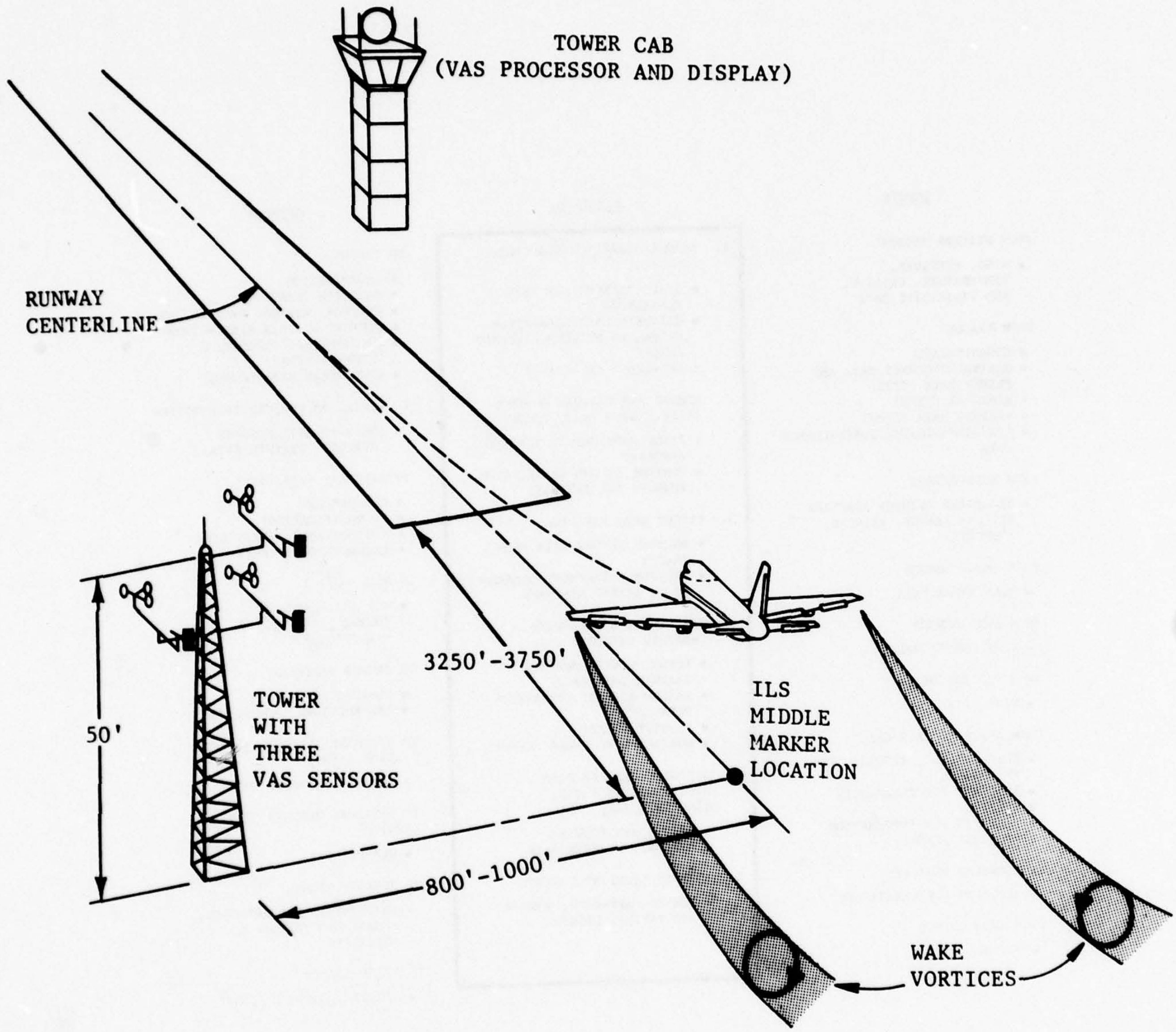


FIGURE 4-7
VORTEX ADVISORY SYSTEM (VAS)

To improve the capacity of some high IFR activity airports, the FAA plans to install a VAS (Reference 4-1) at the airports. VAS does not detect the presence of the wake vortices but rather the magnitude and direction of the wind. It then estimates whether the current wind conditions are strong enough to dissipate or move these vortices away from the approach path. VAS is being designed to reduce the longitudinal separation between arriving aircraft to 3 nautical miles for all types of aircraft when the wind's magnitude exceeds a threshold value which varies as a function of wind direction.

VAS will consist of three Sensors along each approach path that will be monitored, a VAS Processor in the tower, and VAS Displays in the Tower Cab and TRACON. The VAS Sensors will be placed on 50 foot towers which will be located near the middle markers associated with the approach paths. The wind information (magnitude and direction) will be periodically sampled and forwarded to the VAS Processor which will utilize a relatively simple algorithm, based upon the average wind direction and magnitude, to determine the aircraft separation criteria.

The air traffic controllers in the TRACON will utilize the information presented on their VAS Display(s) to adjust the separation distance between arriving aircraft. When the aircraft are handed off to the air traffic controllers in the Tower Cab, the controllers there will use the information presented on the VAS Display(s) in the Tower Cab to insure that the proper separation distances between aircraft are in effect at the time.

If they are not, the pilots may be told to go around for another approach.

2. Low Level Wind Shear Alert System (LLWSAS)

Another safety problem that effects aircraft operating in the vicinity of airports is low level wind shear.

One of the most common causes of wind shear is a severe thunderstorm. This type of wind shear is accompanied by an increase in pressure, a shift in wind direction and magnitude, and a decrease in temperature.

To detect wind shear associated with a thunderstorn, the FAA is planning to install a LLWSAS (Reference 4-2) at most high IFR activity airports to measure the wind's direction and magnitude. This information will be periodically sampled at sensors deployed around the airport's periphery and sent to the tower where a LLWSAS Processor will compare the peripheral wind information with the wind at the airport's center. If there is a vector difference of 15 knots between the wind velocity at any peripheral sensor and the center sensor, a wind shear alert will be given to the pilots by the air traffic controllers in the Tower Cab. The pilots will then decide whether or not to abandon their approach. The controllers in the Tower Cab will also notify the air traffic controllers in the TRACON about the existing wind shear condition.

Since there is such a great amount of similarity between

the VAS and LLWSAS, the FAA is considering the use of common sensors, processors, and displays at those airports where both systems will be deployed.

4.3.2 Far Term Improvements

There are five possible Far Term improvements that would impact the external information flow or the internal functions performed at a Tower Cab located at a high IFR activity airport.

1. Wake Vortex Avoidance System (WVAS)

WVAS (Reference 4-1) would evolve from VAS by adding WVAS Sensors, and modifying the ACD Processor and Displays. With these changes, the presence of wake vortices along the approach paths would be detected, tracked, and forecasted 10 to 20 minutes into the future. This information, in turn, would be used by the metering and spacing algorithm in the ARTS III Processor to dynamically adjust the longitudinal separation between arriving aircraft to the minimum safe value.

A WVAS Sensor would detect and track the vortices located along each approach path. Several types of sensors are currently being studied by the FAA for use as the WVAS Sensor: acoutic doppler systems, pulsed or CW lasers, and an array of anemometers. At the present time, a linear array of anemometers deployed at a right angle to the runway centerline appears to be the most likely sensor choice.

The wake vortex data from the WVAS Sensors and the wind data from the VAS Sensors would be sent to the

ACD Processor located in the tower. There the data would be processed to determine the minimum longitudinal separation between successive aircraft along the approach path. This information would then be automatically forwarded to the ARTS III Processor in the TRACON for use as an input to the metering and spacing algorithm. Separation distances as low as two miles between aircraft may be permitted by WVAS under optimum conditions.

2. Advanced Wind Shear Detection System (AWSDS)

Since the LLWSAS relies upon wind measurements taken at ground level, it can only detect wind shear created by strong updrafts and downdrafts such as a thunderstorm or a cold front. However, there is another type of wind shear, associated with warm fronts and low level temperature inversions, in which the wind conditions on the surface are constant but different from the wind conditions above, thereby creating a change in the wind conditions encountered by an aircraft as it descends during a landing. Since the AWSDS Sensor (Reference 4-2) would directly measure the wind shear condition along the approach path, it could detect both types of wind shear.

AWSDS would consist of an AWSDS Sensor located at the airport, the ACD Processor in the tower, and the ACD Displays in the Tower Cab and TRACON. The AWSDS Sensor would probably be the Joint Use Weather Radar described in Chapter 7. However, it should be noted that the FAA is also looking at pulsed or CW laser systems as an alternative to the weather radar.

The wind shear data would be sent from the AWSDS Sensor to the ACD Processor in the Tower Cab. The controllers in the Tower Cab would be alerted to the presence of hazardous wind shear conditions by the ACD Display driven by the ACD Processor. The ACD Processor would also automatically forward wind shear information to the ACD Display in the TRACON to alert the controllers there.

3. Tower Automated Ground Surveillance (TAGS) System

TAGS (Reference 4-3) is being developed for use at a few high IFR activity airports in order to display flight identity information on arrivals and departures. This information would either be placed on the ASDE Display in addition to the ASDE-3 search radar data, or possibly on a separate TAGS Display.

The FAA is currently exploring several alternate TAGS configurations. The most likely configuration utilizes ATCRBS trilateration to provide aircraft position and identity data. In this configuration, two or more TAGS beacon interrogators located at an airport would interrogate an individual aircraft's ATCRBS transponder at the airport by dividing the airport's area into small rectangular cells (150' by 150') and successively interrogating predetermined cells of interest. Replies from other aircraft at the airport would be electronically inhibited, thus allowing only one aircraft to respond at any given time.

The ATCRBS transponder replies from each aircraft would be received by three or more TAGS beacon receivers at

the airport and sent to the TAGS Processor in the tower. The processor would use this information to determine the aircraft's position. The aircraft identity information (beacon code) contained in the transponder replies would be compared in the TAGS Processor with the list of beacon codes versus flight identity information sent by TIPS, thus allowing the aircraft's flight identity to be displayed on the combined ASDE-3/TAGS Display instead of beacon code.

4. Visual Confirmation of Voice Takeoff Clearance (VICON)

VICON systems may be added at most airports with a control tower. VICON would consist of a set of signal lights at all runway departure points and a control panel in the Tower Cab. When the controller cleared an aircraft for takeoff via voice communications with the pilot, he would also turn on the three VICON lights at the appropriate departure point to confirm the clearance. After the aircraft had started its takeoff, the VICON lights would be automatically turned off.

5. Terminal Information Processing System (TIPS)

The FAA may replace the FDEP equipment in all Tower Cabs with TIPS equipment (Reference 4-4) in order to speed up the flow of flight plan and weather data, and to eliminate the need for flight progress strips by utilizing electronic tabular displays.

TIPS would consist of a TIPS Processor located in the tower and TIPS Displays located in the TRACON and Tower Cab. The TIPS Processor would interface with the ARTS III Processor, the ARTCC and the TIPS Displays, and would

control the flow of flight plan data between them. In addition, TIPS would also distribute weather information and pilot reports (PIREPS). The TIPS Processor would forward weather information, PIREPS, and flight plan data on arrivals and departures to the TIPS Displays in the Tower Cab where it would be monitored and revised by the air traffic controllers.

4.4 Tower Cab Improvements Tentative Implementation Schedule

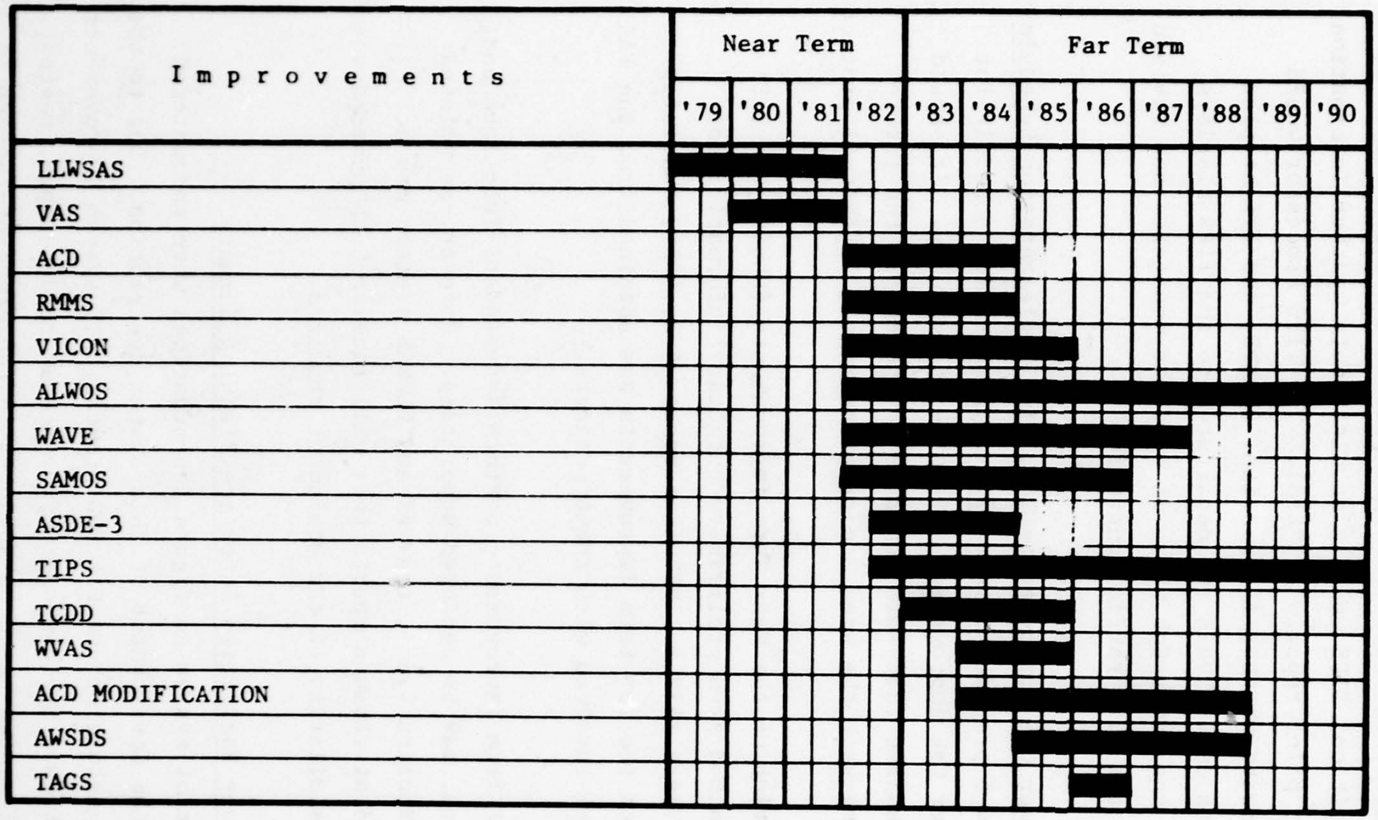
Figure 4-8 provides a tentative implementation schedule for the Tower Cab improvements discussed previously. It should be emphasized that this schedule may change in the future depending upon the need and progress of the individual projects.

Information on the Near Term improvements (LLWSAS and VAS) was obtained from preliminary budgetary information for Fiscal Years 1977 to 1980 (References 4-2, 4-5), and information on the far term improvements was obtained from the FAA personnel involved with these projects.

The Near Term improvements perform independent functions and, therefore, may be deployed separately. However, as pointed out in Section 4.3.1, the VAS and LLWSAS systems may be combined at those airports that will receive both systems due to the similarity of the equipment required.

4.5 Tower Facilities Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 4-8
TOWER FACILITIES IMPROVEMENTS TENTATIVE IMPLEMENTATION SCHEDULE

technology and perceived changes in operational needs. This results in keeping open the various options for implementing the output of the E&D program until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in the tower facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "Open Items."

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, an Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the tower facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for tower facilities. Instead, they might be contained within the program of another interfacing

facility. The assumptions made with regard to the Open Items are:

Open Item 8: VAS/WVAS Interface/Interaction with ARTS III Metering and Spacing and En Route Metering

1. A manual interface will be established between ARTS M&S, the Vortex Advisory System (VAS) and en route metering that will permit the use of reduced longitudinal separations when the VAS indicates that wake vortex conditions are favorable.

2. As the VAS evolves to a more capable Wake Vortex Avoidance System (WVAS) an automated interface will be implemented between the cited system elements to allow the benefits of further reductions in longitudinal spacing (possibly tailored on an aircraft pair basis) to be operationally realized.

Open Item 12: Terminal/Tower Display and Integration of E&D Products

1. The existing terminal displays for visibility, ceiling, wind, barometric pressure, time, vortex advisories, wind shear, and the status and control monitors for airport communication, navigation, and surveillance systems located in TRACONS and Tower Cabs will be integrated into an operationally efficient design that uses hardware that also incorporates a remote maintenance and monitor processing capability.

2. Subsequent to the above system improvement, the controller interface equipment located in Tower Cabs at major airports will be sufficiently integrated with

proposed new systems to permit an operationally efficient installation of a full complement of new equipment including TIPS, ASDE-3, TAGS, Wake Vortex Avoidance Systems, and Advanced Wind Shear Detection Systems.

Open Item 15: Voice Communications Planning

1. Air-ground-air communications for the ARTCCs and major terminals will be upgraded in the post-1982 time period by implementation of the radio portion of VSCS, which would be referred to as RCCS. In the near term, RCAG tone control equipment for the ARTCCs will be replaced, possibly with a modular subsystem that would be compatible with longer term RCCS/VSCS designs. The FSSs, which are assumed to remain unconsolidated, will continue to use switching and control equipment based on existing designs. In addition, the transmitters, receivers, and antenna systems at all FAA ground sites will be replaced with modern equipment.

2. Ground-ground communications would be modernized by the implementation of ground-ground portions of the VSCS system which would replace the WECO 300 system at ARTCCs, and the WECO 301 system at the larger terminals. The existing small key systems and call distributors at FSSs would remain in place.

3. At some smaller terminals a Small Voice Switching System (SVSS) will be implemented, which will provide an integrated radio and ground voice communications capability.

Open Item 17: Display of Digitized Surveillance at TRACONs and Towers

1. ASRs associated with ARTS IIIA TRACONs will be modified in the early 1980s to include an ASR weather channel for weather detection and processing and a Moving Target Detector for enhanced aircraft detection. This means that weather and aircraft surveillance information will be in the form of digitized data.

2. All-digital displays will be available at ARTS IIIA sites on a schedule that is compatible with displaying the digitized weather and aircraft data starting in the early 1980s.

3. No expansion of the digital display capability at the ARTS II and TPX-42 locations will be made.

5. AIR TRAFFIC CONTROL SYSTEM COMMAND CENTER

The Air Traffic Control System Command Center (ATCSCC) described in this chapter contains five separate and distinct operational components operating under a center chief. The operational components are:

- Central Flow Control.
- Airport Reservation Office.
- Central Altitude Reservations.
- Contingency Command Post.
- National Weather Service.

These five ATCSCC components currently operate from the System Command Center located in Room 626 of Federal Office Building 10A in Washington, D.C. All of the operational components are manned by FAA employees except for the Meteorologist Duty Officer and his staff, assigned to the ATCSCC by the National Weather Service (NWS).

Central Flow Control (CFC) is to serve as the focal point for: evaluating and approving traffic flow redistribution; nationwide management of air traffic flow and providing the decisive authority that initiates system-wide flow control. Figure 5-1 identifies the current CFC interfaces and capabilities. Figure 5-2 describes the current communications capability.

Several times a day, the CFC specialists in the ATCSCC collect situational reports from each Air Route Traffic Control Center

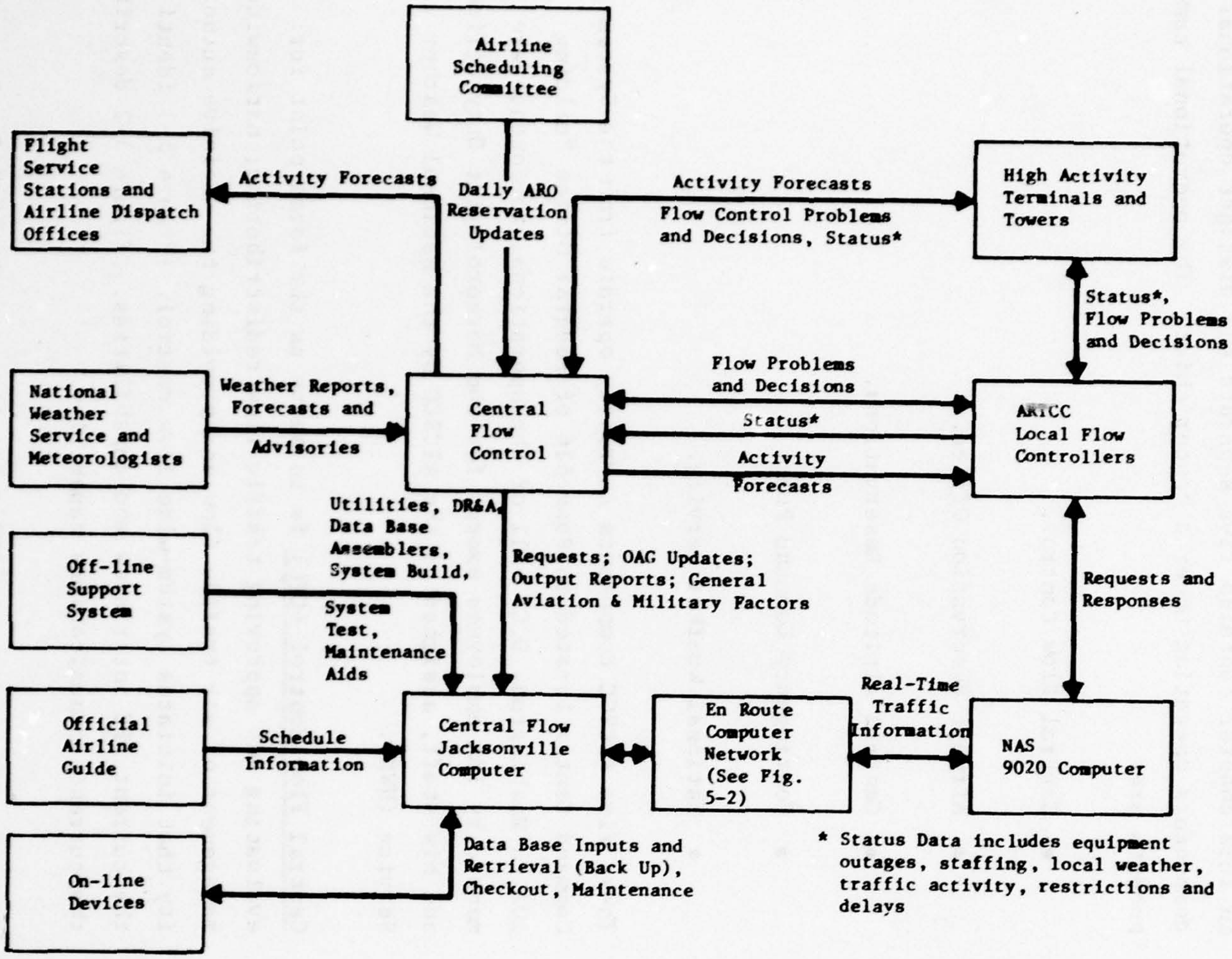


FIGURE 5-1
CURRENT CENTRAL FLOW CONTROL CAPABILITIES

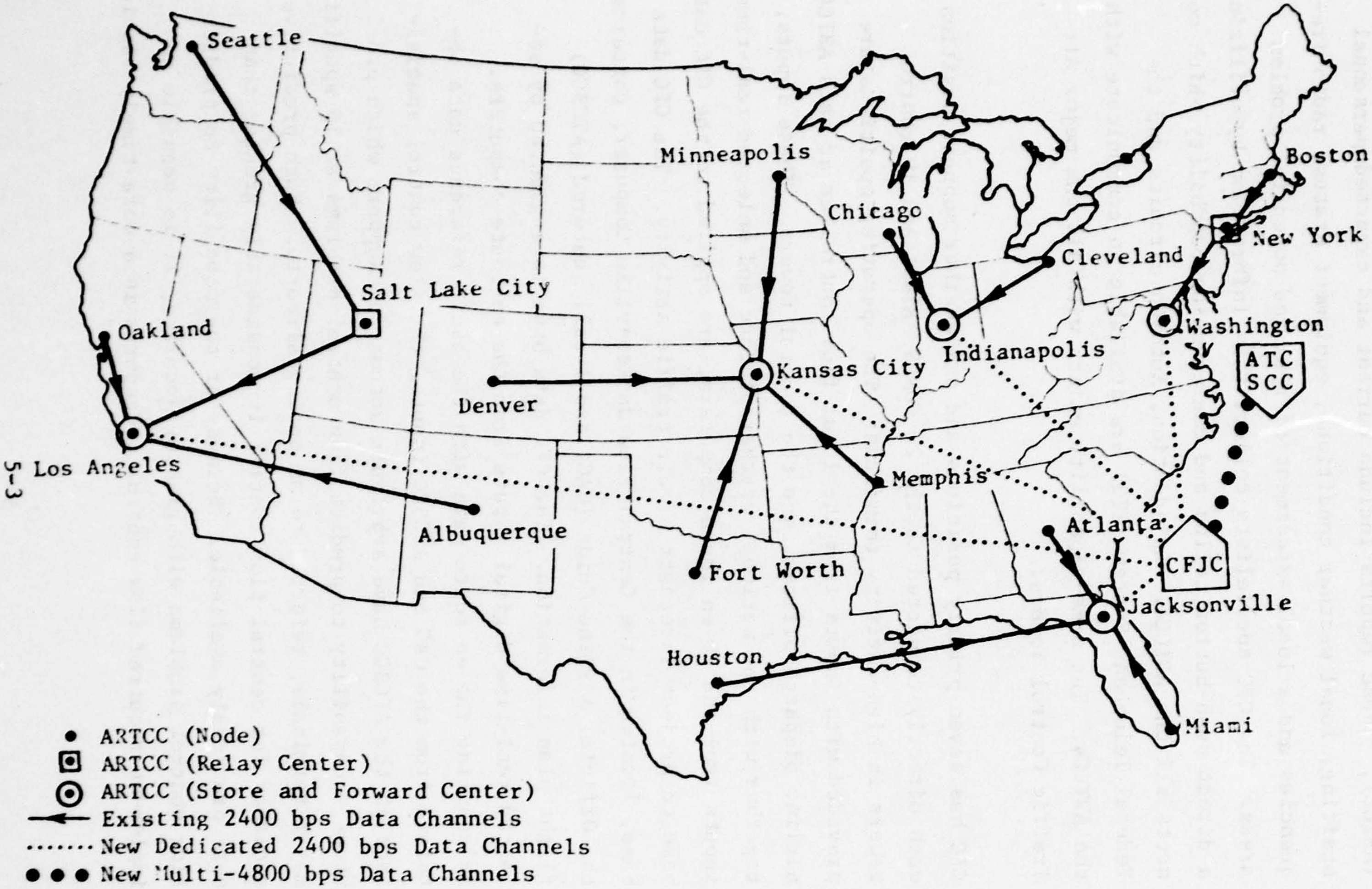


FIGURE 5-2
CURRENT CENTRAL FLOW CONTROL COMMUNICATIONS NETWORK

(ARTCC). These reports include current and expected personnel staffing, local weather conditions, equipment status, radio frequencies and a local assessment of real and potential problem areas. The CFC specialists collect this information by utilizing a direct push-button callup and conferencing capability which connects all the ARTCCs. In addition, Autovon circuits and the Federal Telephone System (FTS) are available to communicate with the ARTCCs. The same capability exists with all the major Air Traffic Control Towers.

CFC has seven primary positions and one weather support position, each directly connected to the 20 CONUS ARTCCs and 19 control towers in high-activity terminals. The operating positions are provided with inputs from the local flow controller at each ARTCC, airline dispatch offices, and the control towers. These inputs, together with the national weather picture and selected real-time inputs from the 20 en route computers, are applied to the CFC data base to project forecasts of air traffic activity. The CFC data base, located in the Central Flow Jacksonville Computer, contains the Official Airline Guide (OAG) and locally entered (ATCSCC) flight plan information. The CFC data base is augmented by selected real-time digital inputs from the en route computers.
By coupling the en route data with the basic reference data obtained from the OAG and ATCSCC inputs, the flow control specialists at the ATCSCC have available automation support which provides a capability to predict flow control problems at 15 specific major terminals, referred to as pacing airports. Such predictive accuracy for central flow control is considerably greater than that previously available. Because of the capability to predict flow control problems with greater accuracy, it is possible to implement required flow control procedures in a more timely fashion

so that traffic flow problems can be alleviated. In concept, this approach differs from the reactive nature of the previous capability wherein procedures had been implemented only after traffic flow problems had surfaced.

The CFC program provides basic data in hourly summary form for each airport's arrivals and departures, simulated delay prediction reports and flow control reports that are used in the Quota Flow and Fuel Advisory Departure flow control procedures.

Analysis of the CFC output messages are made by the CFC specialist and, if warranted, traffic forecasts and traffic quotas are forwarded to the appropriate ARTCC via Center B teletypewriter or directly to an ARTCC and major terminal via telephone.

The Airport Reservation Office (ARO) is designed to relieve congestion at the four highest activity airports. Reservations to and from LaGuardia, John F. Kennedy, Washington National and O'Hare airports are made for a 60-minute period beginning with the first second after the hour for high activity hours.

Commercial air carriers receive the bulk of the allocations based upon the published schedules. Additional sections of a scheduled flight (e.g., shuttles) carry the same reservation as the scheduled flight regardless of the number of sections. Each afternoon, a courier from the Airline Scheduling Committee delivers requested modifications to the schedules. The ARO coordinates with the affected airports and makes adjustments as may be necessary. Air taxis receive a second allocation (also based on schedules) with general aviation and the military receiving those allocations that remain.

The ARO uses listings provided by CFC of air-carrier aircraft arriving at the four major terminals and inserts reservations into any remaining vacant slots as non-air carrier pilots call in requests to the ATCSCC. In the event that a slot is not available, the closest time slot is proposed. If no slot is available, the request is denied. Reservations are entered into the CFC data base.

The purpose of <u>Central Altitude Reservation Function (CARF)</u> is to centralize the responsibility for efficiently allocating portions of airspace to military and civil users within its jurisdictional areas. Through the use of airspace reservations, the movement of aircraft is expedited and the total handling capacity of the air traffic control system is greatly increased.

The CARF exists primarily to support the military and to provide coordination with the local flow specialists at the individual ARTCCs by providing detailed, easily interpreted views of pending military exercises including air refueling operations, rocket and missile firings, and VIP flights which require airspace protection. These flights may cross or traverse regularly controlled airspace in a way which would make their presence unsafe for civil aircraft and vice versa. These missions may consist of a solitary aircraft or a flight of two or more aircraft. A suitable protected three-dimensional envelope in the airspace is provided by this function. In addition, a large envelope will be provided around each aircraft during the term of the mission. The size of envelope is determined by the type of mission.

CARF has the authority to allocate defined airspace within the CONUS, Alaska and Hawaii and oceanic centers. In addition, CARF serves as the United States coordination agency for processing airspace reservation requests which will traverse foreign airspace.

Reservations for these special uses of the controlled airspace are made prior to the beginning of the flight or exercise by the cognizant military operations headquarters (e.g., Department of Defense (DOD), Strategic Air Command (SAC), Tactical Air Command (TAC), North American Air Defense Command (NORAD), etc.). Generally, the requests for protected airspace are made well in advance of the proposed event, allowing adequate time for notification and coordination between the impacted facilities (e.g., ARTCCs, Terminals, Military Operations, etc.) by CARF.

The Contingency Command Post (CCP) is installed in a soundproofed, glass enclosed room that overlooks the System Command Center. It is designed to become activated when a major calamity occurs somewhere within the air traffic control system. A calamity such as a catastrophic failure at one of the ARTCCs would require coordination with controllers at each of the adjacent ARTCCs to adjust sector coverages to the extent possible to assure safe transit of aircraft through the airspace normally controlled by the failed center. The CCP is activated to assure unimpeded operation of CFC during the time required to effect and maintain coordination with the affected centers.

The operational aid provided in support of the Contingency Command Post (CCP) is in the form of direct access telephone channels to each ARTCC (20) or control tower at high-activity terminals (19). Additionally, limited dialing capability is provided for conferencing up to 40 locations on one call. Rear-screen projectors are also provided which utilize automated slide selection. The communications channels available to the Contingency Command Post are also available for use by the other functions within the ATCSCC.

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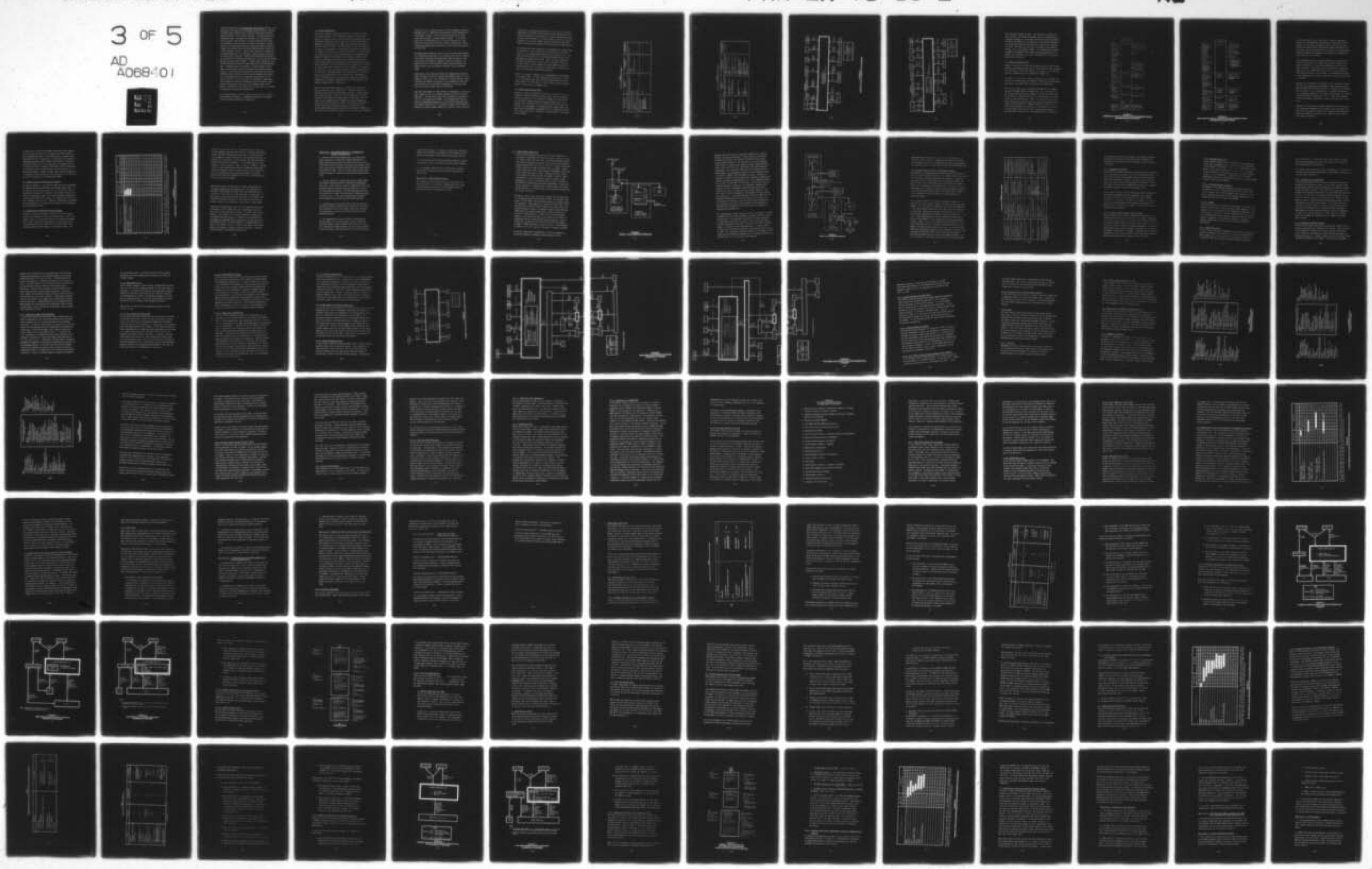


The data provided to the <u>Meteorologist Duty Officer</u> and his staff, assigned to the ATCSCC by the National Weather Service, consists of weather data assembled and correlated from several sources, making available to air traffic personnel a surface analysis of existing weather, the upper-air situation, the orientation of the jet stream, identification of areas associated with clear-air turbulence, and forecasts of terminal conditions. Weather charts of the upper-air conditions (including winds and precipitation) are received from the National Meteorological Center on an NWS facsimile circuit. Some of these charts are transferred to transparancies and are displayed on the wall-size screens by the rear-screen projectors. Weather observations and forecasts are received on a 1200-baud teletypewriter circuit from the Weather Message Switching Center (WMSC). A medium speed (850-baud) data circuit provides forecasts of high winds from the Severe Weather Labs. Facsimile prints (Thermofax) of radar displays from 30 remote weather radar sites are provided over dialed telephone circuits. The Geostationary Operational Environmental Satellite (GOES) provides pictures of short-term development and movement of cloud systems over the 48 contiguous United States at 30-minute intervals. National Oceanic and Atmospheric Administration's (NOAA's) National Environmental Satellite Service transmits the satellite picture data over telephone lines to the ATCSCC. The ATCSCC can retransmit this picture data to 14 ARTCCs by telecopier in less than five minutes.

Voice communications and data communications used by the ATCSCC are described in Chapter 9. Messages generated in the ARTCCs for use by CFC are described in Chapter 2.

5.1 ATCSCC Improvements

The future automation improvements within the ATCSCC are basically enhancements to CFC through the addition of functional modules, the replacement of the dedicated CFC communications with the general purpose National Airspace Data Interchange Network (NADIN), the automation of the ARO, and providing an automated plotting system for CARF. The improvements to CFC are expected to result in an expanded and improved data base that is expected to provide a forecasting or predicting capability to assure that all significant flow control problem areas are recognized early enough to enable flow adjustments to be made to eliminate the problem or minimize its effects on the national flow control picture while minimizing unnecessary flow adjustments and false-alarm conditions. The CFC improvements are expected to be made on an evolutionary basis especially as more experience is gained in the operation of the simulation functions and the manipulation of the data base. The improvements are envisioned to be in the expansion and modification of the CFC data base, refinements in traffic loading analysis and simulations, improved reliability, introduction of graphics capabilities for CFC specialists, and expanded communications capabilities.

Near Term software improvements for Central Flow Control will provide added functional capabilities. Functions being considered for Near Term CFC enhancements include: output message edit capability where review of output messages may be accomplished at the ATCSCC and changes made, if necessary, prior to output on the communications network; CFC output messages directed onto the teletypewriter network from either the ATCSCC or CFJC based upon an operator request or program control; General Information message input using the available communications network; and additional inputs from en route and/or terminal

facilities (e.g., progress reports, arrival messages, diversion messages, etc.). Additional functions also being considered to be provided include: traffic load predictions for en route fixes and activation of international flights. It is anticipated that the implementation of new CFC features will occur cyclically based upon the previous phases capabilities, future system requirements and availability of new system data sources or functions.

By adding these additional inputs to the data base and refining the forecasting techniques, it is expected that CFC will improve the activity forecasts and permit more timely actions to take place which will minimize congestion around all domestic terminals and in en route airspace, reduce airborne delays, and manage traffic flow with greater precision than is possible today.

Additionally, the present CFC dedicated communications network shown in Figure 5-2 may be replaced with NADIN II when it is implemented (see 9.1.2). The integration of ATCSCC digital communications into NADIN can provide for the expansion of CFC data collection and for the broader dissemination of Central Flow Control and other ATCSCC reports or decisions.

Near Term improvements to ARO include the automation of the function through the use of the NADIN communications with the CFC data base. The ARO function has been relocated to the CFJC facility at the Jacksonville ARTCC. The automated ARO function will be accomplished through the use of the CFC data base which will enable reservations to be entered through an ARO operator's keyboard for those flights expected to arrive at one of the four

reservation controlled terminals when a slot time is available. Monitoring of available slots within the CFC data base will be possible through the CFC arrival list routine which will include all previously reserved air carrier flights, as well as any supplementary air carrier flights, general aviation and military flights which have been granted reservations by the ARO operator.

An automatic plotting system will be provided to the CARF during the Near Term. This function will be relocated to the CFJC facility at the Jacksonville ARTCC early in the Near Term. The CARF plotting function will be provided through the use of the CRT graphics capabilities of CFC. Plots will be presented to the CARF operation that compare routes, altitudes, and areas of high traffic activity against all other CARF requests previously entered into the system to assure that no conflicts result in the altitude reservations functions.

Table 5-1 contains a summary of the improvements in the ATCSCC for the Near Term. Far Term improvements have not been defined. All of the improvements that have been identified are in CFC, hence, Table 5-2 is provided to identify the envisioned improvements in CFC features in summary form.

5.2 ATCSCC System Connectivity

Figures 5-3 and 5-4 show the interfacility connectivity for the Current and Near Term ATCSCC, respectively. As these figures illustrate, except for the addition of FSDPS, the connectivity for the ATCSCC remains constant through the Near Term. The changes noted on Figure 5-4 result from the CFC functional additions, the replacement of the dedicated CFC digital data communications with NADIN II and NADIN III (for the FSS and military base operations) and the relocation of ARO and CARF to the Jacksonville ARTCC.

TABLE 5-1
ATCSCC FACILITY IMPROVEMENTS SUMMARY

FUNCTIONS/FEATURES	CURRENT SYSTEM (1978)	NEAR TERM IMPROVEMENTS (1979-82)	FAR TERM IMPROVEMENTS (POST-1982)
1. Provide Central Flow Control Analyses (See Table 5-2)	Basic Central Flow Control Functions Dedicated CFC Communications	Central Flow Control Enhancements NADIN II	Not Defined
2. Provide Airport Reservations	Manual	Automatic	NC
3. Provide Central Altitude Reservations	Manual	Automated Plotting System	NC
4. Provide Contingency Command Post	Manual	NC	NC
NON-FAA FUNCTIONS (NWS)			
5. Provide current and forecasted weather information and weather advisory services to FAA	Manual	NC	NC

TABLE 5-2
CENTRAL FLOW CONTROL IMPROVEMENTS SUMMARY

FUNCTIONS/FEATURES	CURRENT SYSTEM (1978)	NEAR TERM IMPROVEMENTS (1979-82)	FAR TERM IMPROVEMENTS (POST-1982)
1. Provide and manage data base	Dynamic - Domestic (OAG supplemented by ARTCC and operator inputs)	Dynamic - Domestic and foreign flights data base providing traffic loading analysis using en route fixes	Not Defined
2. Provide simulations	Based upon dynamic data base for 15 pacing airports	Expanded capability to include more airports	
3. Provide data base updates	On-line departure messages for flights to 15 pacing airports	On-line progress reports, arrival and diversion messages On-line activation of international flights	
4. Distribution of Central Flow Control Info.	Semi-automatic TTY (Center B) Telephone	Automatic TTY (Center B) replaced by NADIN II and message edit capability prior to output on communications network	
5. Provide Communications Capabilities	Telephone TTY (Center B) Digital Data circuits from 5 ARTCCs	Same as present system TTY and Dedicated DDCs replaced by NADIN II On-line general information message exchanges	

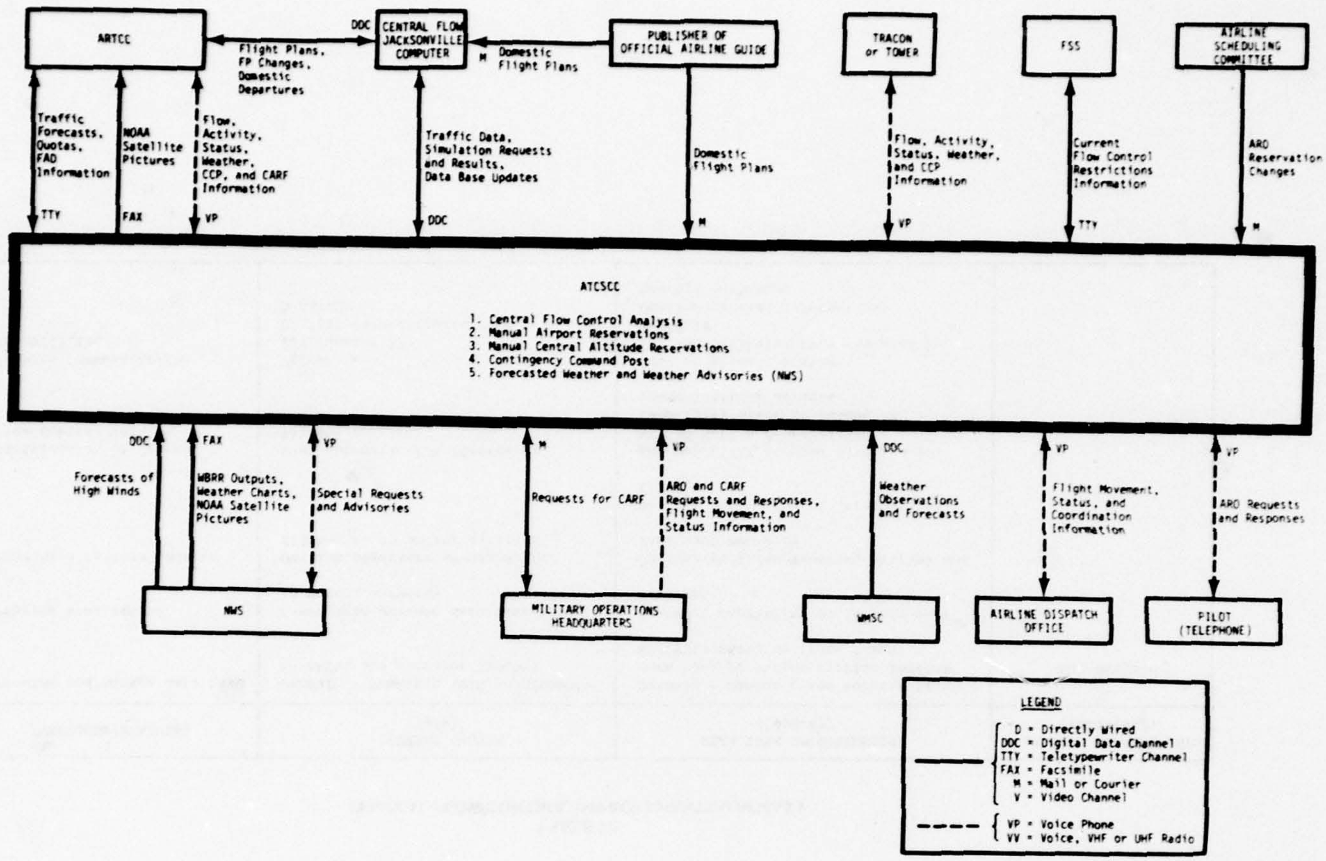


FIGURE 5-3
CURRENT ATCSCC CONNECTIVITY DIAGRAM

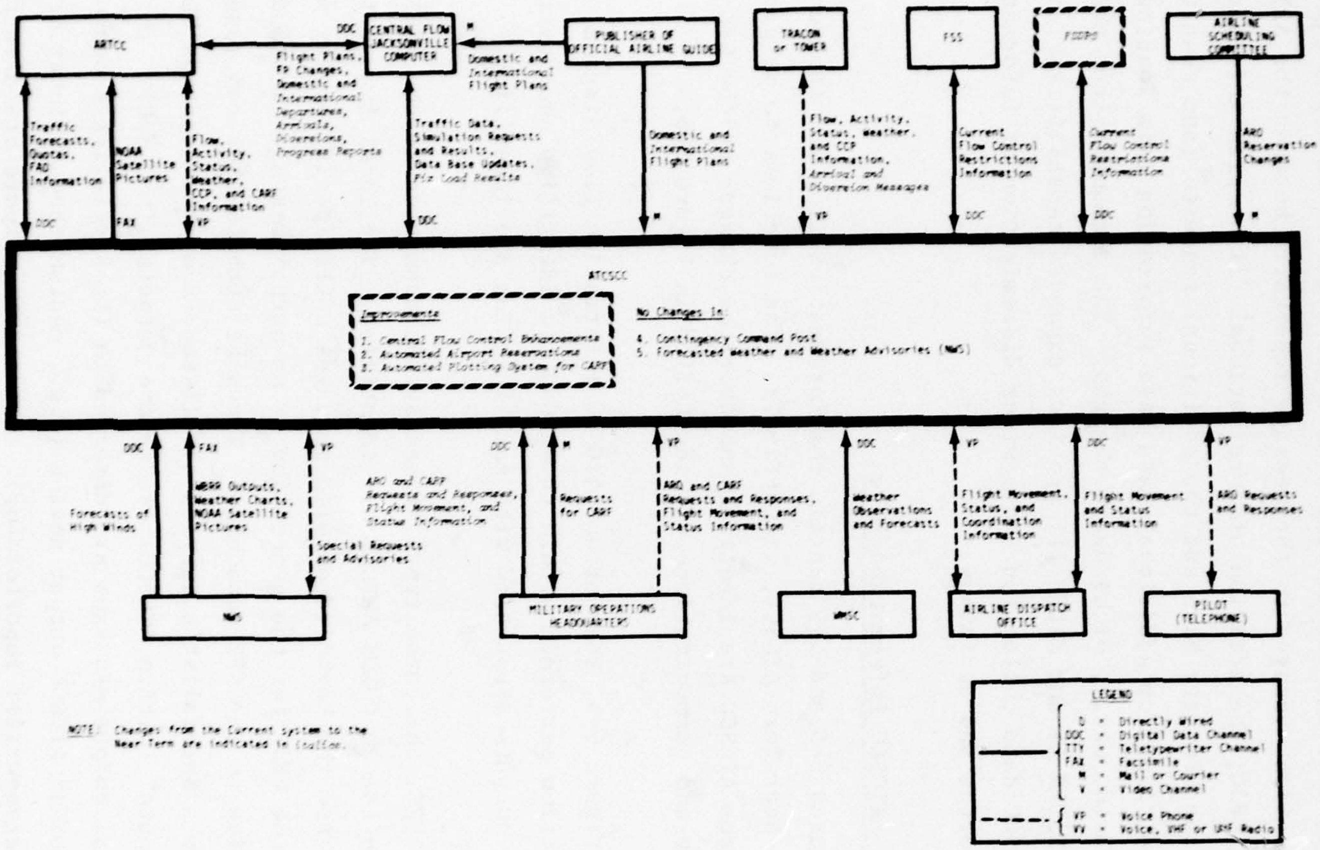


FIGURE 5-4
NEAR TERM ATCSCC CONNECTIVITY DIAGRAM

The functional changes include: the addition of progress report, arrival, and diversion messages together with general information messages to the message repertoire between the ARTCCs and CFJC; the addition of international flight plan information to the CFC data base and the additional requests (and results) resulting from additional data base information (fix loading results, etc.), or hardware changes. The communications change to NADIN II and NADIN III provides expanded capabilities for ATCSCC data collection and a wider dissemination of information, reports, and decisions.

5.3 ATCSCC Information Flow

Figures 5-5 and 5-6 contain the information flow for the Current and Near Term ATCSCC, respectively. The functions to be provided by the ATCSCC are identical, however the changes to the CFC data base and communications are identified in Figure 5-6.

In Figure 5-5, the Current ATCSCC information flow diagram, each function performed within the ATCSCC is identified and the inputs and outputs associated with each function are identified.

For CFC, the three types of messages transmitted to the ATCSCC from the 20 CONUS ARTCCs are identified. The local inputs to CFC are the keyboard entered messages a CFC Specialist may make to the CFJC for the generation of an output message or a modification to the CFC data base. Types of outputs that can result from a Specialist's entries are listed under the headings "Local Outputs" (within ATCSCC) or "Remote Outputs" (to CFJC). The local output messages are directed to the Specialist's console or other ATCSCC output device (e.g., medium speed printer or teletypewriter reperforator). The remote outputs are directed

INPUTS	ATCSCC FUNCTIONS	OUTPUTS
From ARTCC • Flight Plan for each non-air carrier flight that plans to land at a pacing airport • Departure Message for each flight going to a pacing airport • Remove Strip Message for each proposed flight that intended to land at a pacing airport but has cancelled the flight plan From OAG • Flight Plans for all domestic air carrier flights From Central Flow Controllers (Local Inputs) • Request for data count (6 message types) • Request for data list (5 message types) • Request for Simulation (6 message types) • Data Base updates (6 messages)	1. Provide Central Flow Control Analyses	To Central Flow Controllers (Local Outputs)* • Data Counts (6 message types) • Data Lists (5 message types) • Simulation Results (6 message types) • Data Base Update Acknowledgements (Remote Outputs)** Same as Local Outputs but directed to CF2C peripheral devices. To ARTCC: • Traffic Forecasts • Traffic Quotas • FAD Information *Output directed to selected device(s) consisting of: Computer Readout, Console Printer, Medium Speed Printer or Teletypewriter Reperforator **Output directed to selected device(s) consisting of Computer Readout, Console Printer, High-Speed Printer or Teletypewriter Reperforator
From Airline Scheduling Committee • Air Carrier Reservation Allocations • Daily proposed modifications to Air Carrier Reservations From Pilots (Air Taxi, GA, & MIL) • Request for Arrival or Departure Slot at a high density airport during high activity hours • Cancellation of Slot Reservation	2. Provide Airport Reservations	To General Aviation and Military Pilots Via ARO Personnel • Reservation Confirmation • Acknowledgement of Reservation Cancellation • Acknowledgement of Reservation Modifications
From Military • Request for Altitude Reservations to accommodate military exercises and VIP flights • Cancellation of Altitude Reservations	3. Provide Central Altitude Reservations	To Military via CARF Personnel • Altitude Reservation Confirmation • Acknowledgement of Altitude Reservation Cancellation
From ARTCC, TRACON/Tower, Air Carrier • Request for assistance in handling calamity or impending calamity	4. Provide Contingency Command Post	To Initiator via CCP Duty Officer • Policy Assistance and Advisories • Communications Monitoring
	NON-FAA FUNCTIONS (NWS)	
From National Meteorological Center • Satellite Picture • National Weather Reports • Forecasts From Remote Weather Radars • Weather Maps	5. Provide current and forecasted weather picture in addition to weather advisory services to FAA	To SCC Specialists • National Weather Reports • National Weather Forecasts • Detailed Weather analysis for areas of interest To ARTCCs (14) • NOAA Satellite Pictures

FIGURE 5-5
CURRENT AIR TRAFFIC CONTROL SYSTEM COMMAND CENTER INFORMATION FLOW DIAGRAM

INPUTS	ATCSCC FUNCTIONS	OUTPUTS
From ARTCC • Flight Plan for each non-air carrier flight • Departure Message for each flight • Remove Strip Message for each proposed flight that has cancelled the flight plan • Progress Report • Arrival Message • Diversion Message From Terminal • Arrival Message • Diversion Message From International Air Carriers • Departure Message for each international flight From OAG • Flight Plans for all domestic and international air carrier flights From Central Flow Controllers (local Outputs) • Request for data count (6 message types) • Request for data list (5 message types) • Request for Simulation (6 message types) • Data Base updates (6 messages)	1. Provide Central Flow Control Analyses	To Central Flow Controllers (Local Outputs)* • Data Counts (6 message types) • Data Lists (5 message types) • Simulation Results (6 message types) • Data Base Update Acknowledgments • Fix Load Results (Remote Outputs)** Same as Local Outputs but directed to CFJC peripheral devices or output into NADIN for ARTCC(s) and/or Terminals To ARTCC • Traffic Forecasts • Traffic Quotas • FAD Information * Output directed to selected device(s) consisting of: Computer Readout, Console Printer, Medium Speed Printer, or Teletypewriter Reperforator ** Output directed to selected device(s) consisting of Computer Readout, Console Printer, High-speed Printer or Teletypewriter, Reperforator
From Airline Scheduling Committee • Air Carrier Reservations Allocations • Daily proposed modifications to Air Carrier Reservations From Pilots (Air Taxi, GA & MIL) or FSS • Request for Arrival or Departure Slot at a high density airport during high activity hours • Cancellation of Altitude Reservations	2. Provide Airport Reservations Automatically from Jacksonville	To General Aviation and Military Pilots • Reservation Confirmation • Acknowledgment of Reservation Cancellation • Acknowledgment of Reservation Modifications
From Military • Request for Altitude Reservations to accommodate military exercises and VIP flights • Cancellation of Altitude Reservations	3. Provide Central Altitude Reservations with Automatic Plotting System at Jacksonville	To Military via CARF Personnel • Altitude Reservation Confirmation • Acknowledgment of Altitude Cancellation
From ARTCC, TRACON/Tower Air Carrier • Request for assistance in handling calamity or impending calamity	4. Provide Contingency Command Post	To Initiator via CCP Duty Officer • Policy Assistance and Advisories • Communications Monitoring
From National Meteorological Center • Satellite Pictures • National Weather Reports • Forecasts From Remote Weather Radars • Weather Maps	NON-FAA FUNCTIONS (NWS) 5. Provide current and forecasted weather picture in addition to weather advisory services to FAA	To SCC Specialists • National Weather Reports • National Weather Forecasts • Detailed Weather Analysis for areas of interest To ARTCCs (14) • NOAA Satellite pictures

FIGURE 5-6
NEAR TERM AIR TRAFFIC CONTROL SYSTEM COMMAND CENTER INFORMATION FLOW DIAGRAM

to selected devices (e.g., Specialist's Console, high-speed printer, or teletypewriter reperforator) located at the CFJC. Analysis of the output messages are made by the Central Flow Control Specialists and, if warranted, traffic forecasts, traffic quotas, and FAD information are forwarded to the appropriate ARTCC via Center B teletypewriter or directly to an ARTCC and pacing airport via telephone.

After determining the air carrier reservation allocation, the Airport Reservation Office (ARO) uses arrivals listings from Central Flow Control to perform the ARO function at the four major terminals. Reservations for non-air carrier flights are made by the pilot requesting a slot at one of the designated busy airports directly to the ATCSCC. A confirmation or denial of the requested slot is made to the pilot, or an alternate time is provided.

Requests for reservations for special use of controlled airspace are made by the military to the ATCSCC. The Central Altitude Reservations Function (CARF) approves or disapproves the requests well in advance of the proposed event. Approved reservations are coordinated between all the impacted facilities (e.g., ARTCCs, Terminals, Military Operations, etc.) to ensure that adequate protected airspace is provided in concert with the type of mission.

Requests for assistance in handling impending crisis are made to the Contingency Command Post (CCP) where policy assistance and advisories are provided together with communications monitoring until the problem is resolved or the cognizant field facility can handle the problem.

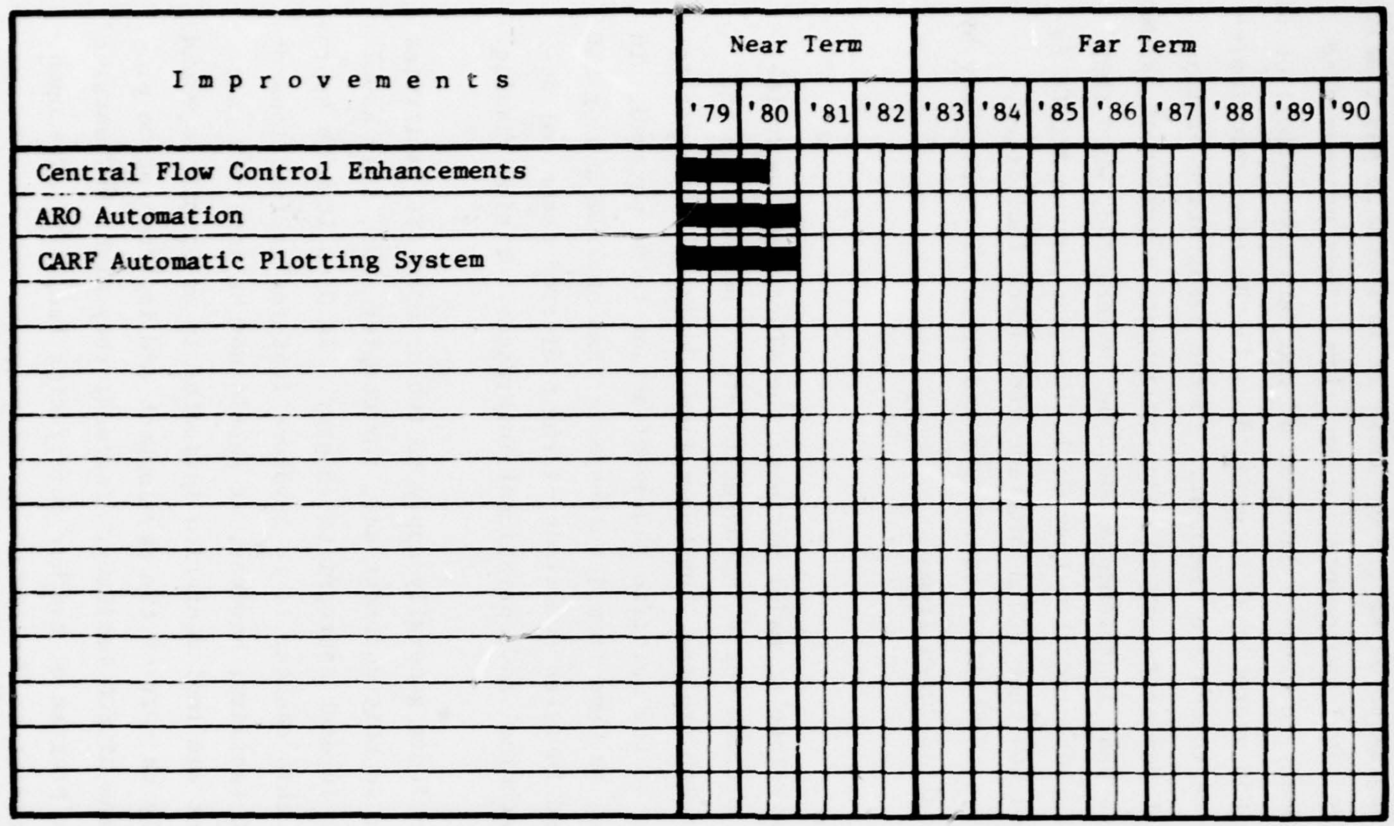
In Figure 5-6, the Near Term ATCSCC information flow diagram, it can be seen that there is no change in the CCP or NWS function's information flow. In the CFC function, changes result from modifications or additions to the data base and changes in communications which permit broader distribution of forecasts and analysis which are of the same type as at present but contain more precision. Changes to ARO result from the automation of the function and its relocation to the CFJC facility at the Jacksonville ARTCC. Changes to CARF result from the addition of an automatic plotting system and the relocation of the function to the CFJC facility at the Jacksonville ARTCC.

5.4 ATCSCC Tentative Implementation Schedule

As shown in Figure 5-7, no specific times have been established for adding the enhanced CFC functions during the Near Term. It is expected that any enhancements to the CFC function will be determined as experience is gained on the present system or as needs are identified, however any future messages required from or directed to ARTCCs will require the communications capabilities of NADIN II (see 9.1.2). Figure 5-7 identifies the schedule for the automation of the ARO and the addition of the automatic plotting system for CARF.

5.5 ATCSCC Facility Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 5-7
ATCSCC FACILITY, TENTATIVE IMPLEMENTATION SCHEDULE

results in the various options for implementing the output of the E&D program to be kept open until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter, it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in the ATCSCC facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "Open Items".

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program, but where final decisions have yet to be made as to the specific course-of-action to be pursued. In most cases, an Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness, they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the ATCSCC facility; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for the ATCSCC facility. Instead, they might be contained within the program of another interfacing facility. The Open Items pertinent to the ATCSCC facility are:

Open Item 1: Interface/Integration of Automated Air Traffic Flow Functions

1. Central Flow Control predictions of en route delay would continue to be improved through enhancements in delay forecasting and more data inputs from the en route and terminal ATC facilities, but Central Flow Control (CFC) would not have any automated interface with En Route Metering or ARTS III M&S. The use of Fuel Advisory Departures would be refined to reflect the improved CFC delay predictions.

2. Initial versions of Flight Plan Conflict Probe (FPCP) and En Route Metering would be developed as independent functions. Later versions would be integrated so that the En Route Metering advisories would provide for conflict-free metering instructions. En Route Metering would also be developed to consider efficient ways of absorbing delay to conserve fuel. This will include profile descents, speed changes, path stretching, and holding patterns.

3. The function of Local Flow Control and the concept of providing information specifically tailored for the Local Flow Controller will not be improved upon over and above the improvements that will be associated with En Route Metering and FPCP.

4. The implementable version of ARTS III Metering and Spacing (M&S) will include flexible control algorithms that will permit profile descents with little or no vectoring during low demand periods, and will utilize tighter control procedures with potentially more vectoring during

high demand periods. The tighter procedures are invoked to improve the interarrival spacing at the threshold and thus maintain high runway capacity during high demand periods.

5. An interface will be developed between M&S and terminal area Conflict Alert to provide conflict-free M&S commands.

6. An automated interface will be developed to maximize efficiency of operations between En Route Metering and ARTS III M&S.

Open Item 13: ATCSCC-NADIN Interface

The communication services provided to the Central Flow Control function of the ATCSCC by NADIN will be at least as operationally effective as the pre-NADIN dedicated Central Flow Control communication set-up.

6. FLIGHT SERVICE FACILITIES

This section considers those facilities which support the provision of preflight and inflight services primarily to non-air carrier pilots and air crews. Preflight briefings provide the latest information regarding current and forecast weather, general flying conditions and the status of airspace and navigational facilities along the planned route of flight. Either Visual Flight Rule (VFR) flight plans or Instrument Flight Rule (IFR) flight plans may be filed. Inflight services include the provision of updated weather information, traffic control information to aircraft unable to contact an ARTCC, flight assistance to lost or disoriented pilots, flight following of VFR aircraft in hazardous areas and coordination of search and rescue operations. Communications, weather radar, and navigational aids are not included except as interfacing or supporting the primary facilities.

During the current time period, the primary facility described is the manual Flight Service Station (FSS). For the Near Term, Model 1 of the Flight Service System automation program provides the framework. (See Figure 6-1). During the Near Term, Flight Service Data Processing Systems (FSDPS) will be providing centralized computer support to Automated Flight Service Stations (AFSS) while the manual Flight Service Station continues to function in some locations. Model 1 will provide automated support to the specialist both for the entry and retrieval of information and for automated data base maintenance. Some 14 FSDPSs will be installed at ARTCC locations and will support a number of AFSSs expected to total 43 or more. FSDPS hardware for Model 1 is to be a subset of the Model 2 computer hardware.

In the Far Term, which includes Model 2 and 3, automation of specialist support is extended by the provision of more

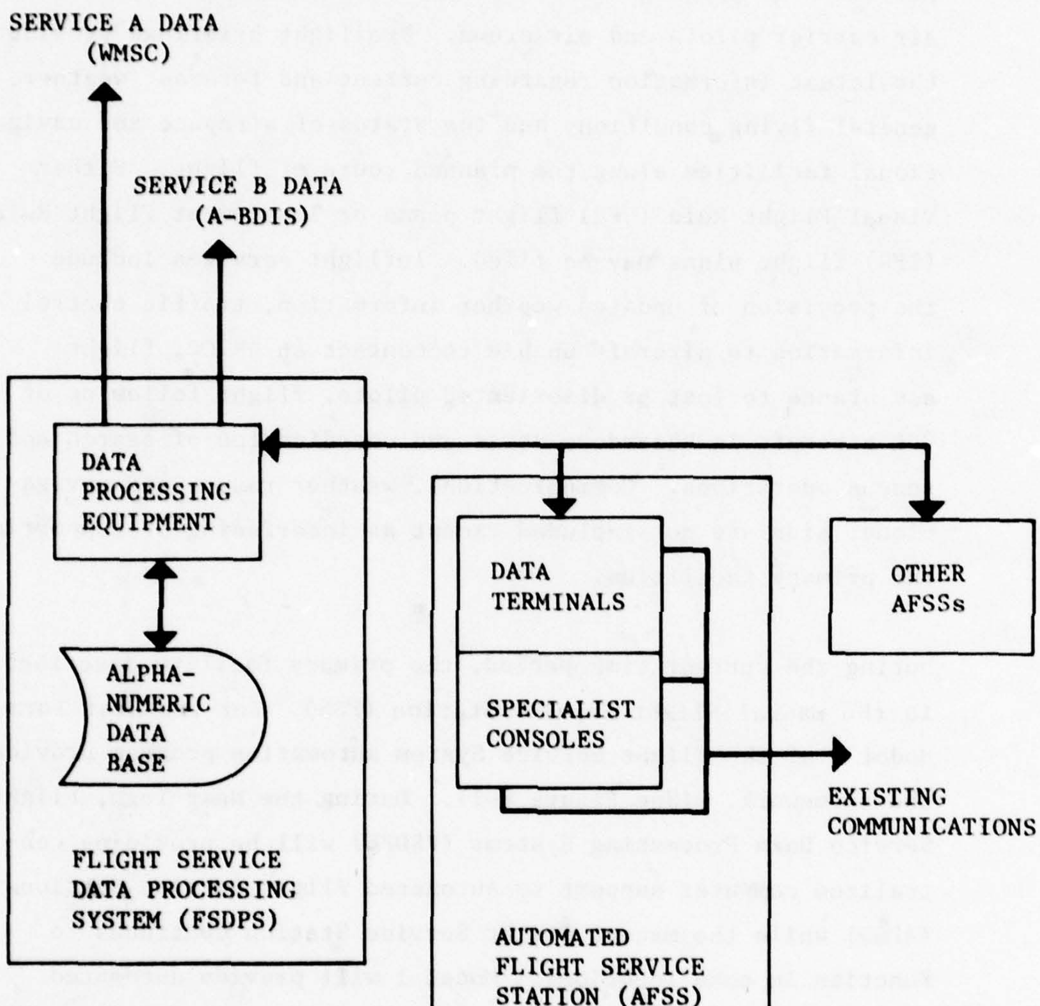


FIGURE 6-1
MODEL 1 FLIGHT SERVICE AUTOMATION

extensive and more selective retrieval capabilities, improved graphics and improved displays. Direct support to the pilot provides for access to the system utilizing the Direct User Access Terminal (DUAT) or via telephone to the Voice Response System (VRS). Although Voice Response System capabilities are shown in the Far Term, these capabilities are being developed independent of any specific Flight Service Automation System (FSAS) model. An experimental version of Voice Response System is currently (Summer 1978) available to pilots. Studies are underway to develop specifications and to evaluate configuration options including the implementation of a Voice Response Capability as early as the Model 1 time frame. For the Far Term, the computer hardware is expected to be expanded, communications capabilities will be enhanced, specialist consoles will be replaced and direct preflight and post flight support to the pilot and air crews is planned to be available from the system (See Figure 6-2). The Aviation Weather Processor (AWP) will be supplying centralized data base maintenance for weather and aeronautical information in the Far Term system including the pilot oriented data base in which weather, and aeronautical information is reformatted and contractions are expanded for improved understandability.

The configuration assumed herein for Model 1 and Model 2 is based on FSDPSs located at existing ARTCCs and AFSSs located at existing FSS sites. An alternative configuration being considered for implementation during the Model 2 time period would additionally consolidate specialist functions at the FSDPS location. However, it should be noted that Reference 6-1 indicates the decision on an alternate consolidated configuration will be made by 1983. The facilities provided at NAFEC for the support of the Flight Service automation program and the training facilities at Oklahoma City are not included in this chapter.

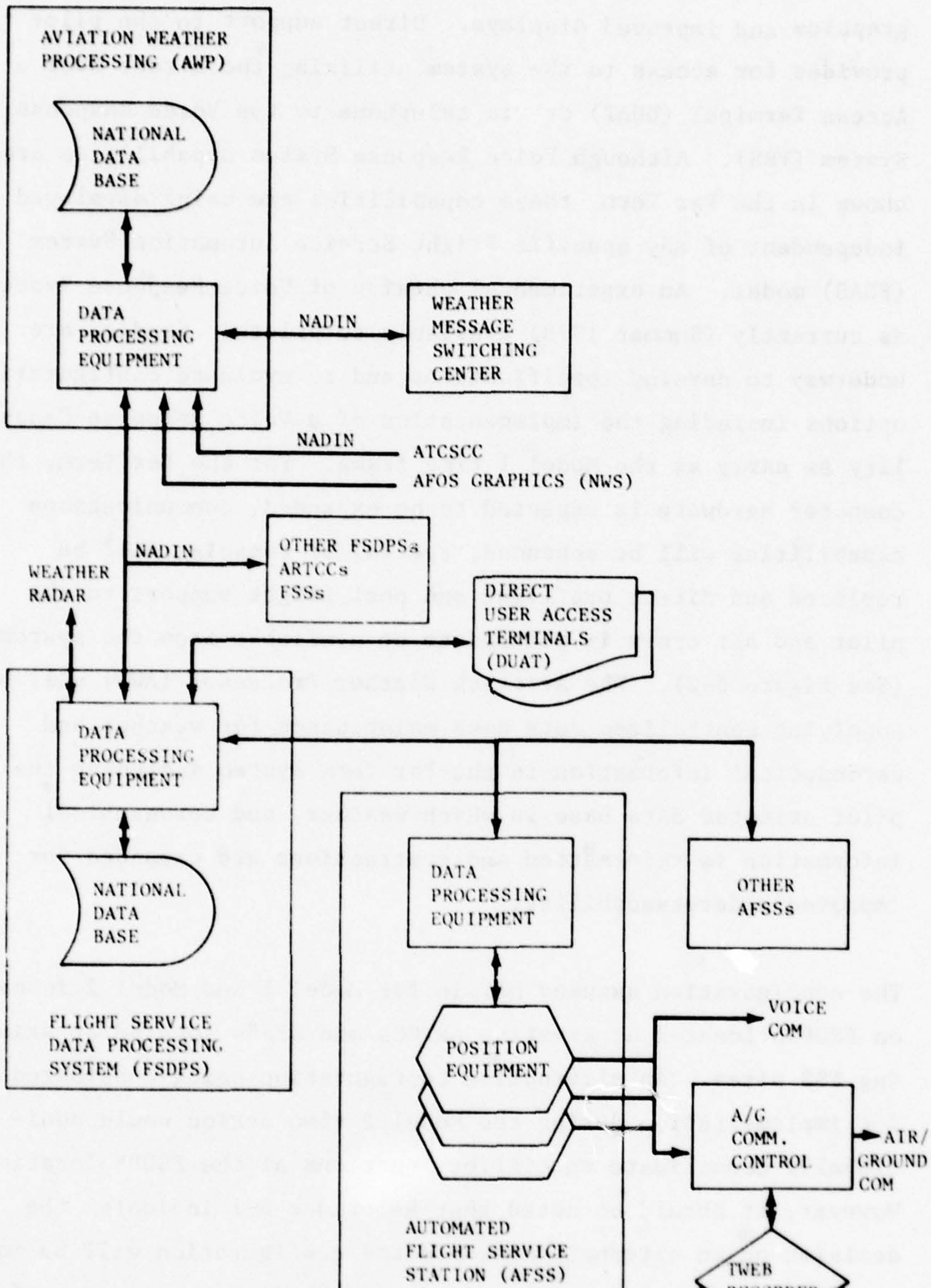


FIGURE 6-2
MODEL 2 FLIGHT SERVICE AUTOMATION

Improvements to Flight Service Facilities are summarized in Section 6.1 which follows. Additional information and details are provided in Section 6.2, Flight Service Facilities Connectivity and Section 6.3, Flight Service Facilities Information Flow.

6.1 Flight Service Facilities Improvements Summary

Improvements to Flight Service facilities have two basic goals: one, to provide automated support to the Flight Service Specialist in carrying out assigned functions, now primarily a manual and laborious process of shuffling paper and preparing inputs and two, to make certain additional services directly accessible to pilots in a convenient and responsive way. The effect of the improvements is to make it possible for Flight Service facilities to provide required services under increasing traffic loads in a more responsive way while minimizing the requirement for increased manning.

The function breakout to be utilized throughout Chapter 6 is shown in the first column of Table 6-1, Flight Service Facilities Summary. It is intended to highlight those functions addressed in the improvements program and is not necessarily inclusive of all functions carried out at Flight Service Stations. In the third column, improvements planned for the Near Term are identified. These improvements are for the Automated Flight Service Stations under Model 1 of the Flight Service Station Automation Program. Model 1 will be the automated system during the time period 1978-1982 and will consolidate automated functions into a number of Automated Flight Service Stations. The fourth column, summarizes improvements expected to be available in the Far Term system (post 1982) which will include the Aviation Weather Processor and additional functions at the FSDPS and AFSS. Each of the functions is described briefly below and the improvements

TABLE 6-1
FLIGHT SERVICE FACILITIES IMPROVEMENTS SUMMARY

FUNCTIONS/FEATURES	CURRENT SYSTEM (1978)	*NEAR TERM IMPROVEMENTS (1978-1982)	FAR TERM IMPROVEMENTS (POST-1982)
1. Emergency Assistance	a. Manual Message Generation b. Manual Location Plotting	a. NC b. NC	a. Automatic Message Generation b. Automated Location Calculation
2. En route Flight Advisory Service (EFAS)	a. Manual PIREP Maintenance b. Manual Weather Plot and Retrieval	a. Automated Support to PIREP b. Manual Weather Plot and Automated Weather Retrieval	a. Enhanced Retrieval Filtering b. Improved Graphics/Radar
3. Data Base Maintenance	Manual	Automated	Centralized and Expanded
4. NOTAM Processing	Manual NOTAM Maintenance	Automated NOTAM Maintenance	Automated NOTAM Accounting
5. Preparation of PATWAS/TWEB	a. Manual Weather Retrieval b. Dictate Recordings	a. Automated Weather Retrieval b. NC	a. Selective Weather Retrieval b. Enhanced Recording including Voice Response System
6. Specialist Weather Briefing	a. Manual Data Retrieval b. FAX Graphics c. Limited Weather Radar	a. Automated Weather Retrieval/Display b. FAX/CCTV Graphics c. Radar at EFAS sites	a. Selective, Filtered Retrieval/Display b. Automated Graphic Display c. Direct/Dial-up of Multiple Radars
7. Specialist Flight Plan Processing	a. Manual Entry/Addressing and Update b. Manual IFR Interaction with ARTCC c. NA d. Manual Suspense List	a. Automated Support to Entry and Update b. Minimal Manual IFR Interaction with ARTCC c. Weather Briefing Coordination d. Automated Alerts	a. Automated Amendment, Departure, Addressing b. NC c. NC d. NC
8. PATWAS/TWEB Access	a. PATWAS via telephone b. TWEB via radio	a. PATWAS via Push-button Control b. NC	a. PATWAS with Voice Recognition System b. NC
9. Pilot Flight Plan Entry/Close	Fast File	NC	Automated via DUAT/VRS
10: Pilot Weather Briefing	NA	NA	Automated via DUAT/VRS

NC = No Change Included in Current Plans
NA = Not Applicable

* Reflects improvements available at the AFSS (not FSS)

to the function over time are traced. The weather briefing function is the primary operational service provided; the ordering of the functions is not intended to relate to load or priority.

6.1.1 Emergency Assistance

This function includes assistance to overdue aircraft and location and guidance assistance to lost or disoriented pilots. In the Current and Near Term system, when aircraft are overdue, appropriate information requests are made to other FSSs and Search and Rescue notices are generated as required. In the Far Term, the system will automatically generate the required information requests and Search and Rescue alerts.

In the Current system, aircraft requiring location guidance are provided such guidance based on navigation aid or manual direction finder (DF) plots prepared by a Flight Service Specialist. In the Near Term there is no change. In the Far Term, location determination and guidance calculations are performed by the computer in response to instructions from the Flight Service Specialist.

6.1.2 En Route Flight Advisory Service (EFAS)

Certain Flight Service Stations provided an EFAS service. In connection with this service, current local weather conditions are solicited from pilots in the form of Pilot Reports (PIREPs) and made available for pilots in the area who request it. In the Current system, PIREPs are manually maintained. In the Near Term and Far Term, automated support is provided for the input, maintenance and retrieval of PIREPs. A weather plot is manually maintained in the Current and Near Term system, while improved graphics and radar would be supplied in the Far Term.

6.1.3 Data Base Maintenance

In the Current system, weather, aeronautical information and flight plan information are received over teletype circuits and are manually maintained. Entry of this same kind of information is made into the teletype system. In the Near Term, automated support is provided to the entry, receipt and maintenance of such information. In the Far Term, data base maintenance functions are performed at both the Aviation Weather Processor (AWP) and the FSDPSs.

6.1.3.1 Aviation Weather Processor

Development of the expanded data base for pilot briefings is performed at the AWP. Manual editing of A/N or Graphic data is also planned for the AWP along with other centralized functions. Regular distribution of the weather and aeronautical information data base is made to the FSDPSs.

6.1.3.2 FSDPS

Data base maintenance at the FSDPS is intended to be fully automated in the Far Term. Multiple weather radar images as well as graphics (e.g., AFOS products) are automatically maintained and distributed to the AFSSs. Weather information converted to the Voice Response System will also be available in the Far Term or sooner if possible. Flight Plan information is exchanged between FSDPSs and sent to ARTCCs and other facilities as appropriate.

6.1.4 NOTAM Processing

In the Current system, the Flight Service Specialist monitors the status of Navigation Aids (NAVAID) in the area of responsibility. When outages occur or are reported, the specialist enters the information into the teletype system and manually maintains a

file for local use. In the Near Term and Far Term, the system will provide automated support to the specialist for entering and retrieving NOTAM information.

In the Near Term, status monitoring is unchanged: in the Far Term the Remote Monitoring and Maintenance System (RMMS) is expected to provide status information.

6.1.5 Preparation of PATWAS/TWEB

In the Current system, weather reports are manually searched to accumulate the applicable reports for the Pilot Automatic Telephone Weather Answering Service (PATWAS) and Transcribed Weather Broadcast (TWEB) recording. The Flight Service Specialist then records the appropriate information for each PATWAS and each TWEB facility. In the Near Term system, retrieval sequences of locations and weather types can be defined for each PATWAS and TWEB report or area or route-oriented retrievals may be made. Recording remains as for the Current system. In the Far Term, the retrieval of weather would be tailored to the specific formats and data to be entered into the PATWAS and TWEB recordings. Improvements to the recording system allow selective changes to a report. For a given location, a single input of a revised report will change the information in all reports including that location.

6.1.6 Specialist Weather Briefing

In the Current system, the specialist maintains a manual file of weather and aeronautical information of interest. When a request for a briefing is received from a pilot, the specialist must either recall the information or search through the reports to find the information. Facsimile graphics are also available from the National Weather Service (NWS). In the Near Term system,

weather and aeronautical data is automatically retrieved from the data base according to a predefined sequence of locations and message types or by route or area. The specialist then extracts information of interest and utilizes it to brief the pilot. Facsimile graphics from the NWS are still available and are distributed within an AFSS utilizing Closed Circuit Television. Weather radar displays are also available at En Route Flight Advisory Service (EFAS) locations. In the Far Term, weather and aeronautical data retrieval is more selective and filtered for use by the specialist. Additionally, graphic products and weather radar images can be selectively retrieved from the data base. Automated graphics are available from the NWS Automation of Field Operations and Services (AFOS) system; weather radar is received from FAA or NWS radar sites utilizing direct and dial-up lines.

6.1.7 Specialist Flight Plan Processing

In the Current system, the specialist files a flight plan for a pilot by entering it into the teletype network and correcting errors reported over the teletype network by the receiving facilities. In the Near Term system, the specialist is provided support by the automated system in formatting and checking the entered data. Error correcting is still done by response to errors reported by the receiving facility. In the Far Term, error checking by the automated system is more complete and is intended to identify all errors that might cause rejection by the receiving facility. Addressing of flight plans is automatic, amendment and departure processing is simplified and supported by the automated system. In the Near Term and Far Term systems, flight plan information supplied during a weather briefing is retained and used in a flight plan to be filed if the specialist so desires. A list of incoming flights is manually maintained

in the Current system. The Near Term and Far Term systems maintain such a list automatically and provide an alert for overdue flights.

6.1.8 PATWAS/TWEB Access

In the Current system, a pilot desiring a PATWAS weather report must call the specific telephone number at which that report is available. In the Near Term and Far Term, different telephone numbers for different routes will not be required; selection of briefings may be by entry of selected information via push button telephone devices. In the Far Term, PATWAS access may also be by use of a limited Voice Recognition System.

TWEB access via radio will be available throughout the time periods covered.

6.1.9 Pilot Flight Plan Entry/Close

In the Current and Near Term system, the pilot must work through an available specialist to file or close a file plan. Alternatively, the pilot may record required flight plan information utilizing the Fast File capability. A specialist will subsequently enter the flight plan into the system. In the Near Term and Far Term, information for a flight plan that was entered in the course of a weather briefing will be available to the pilot for the flight plan without reentry of the data. In the Far Term, the pilot will be able to file or close flight plans using a DUAT in a conversational mode. Also, the pilot may use a push-button equipped telephone to file a flight plan; in this mode automated support includes Voice Response System playback of the data the pilot has entered for confirmation or correction.

6.1.10 Pilot Weather Briefing

In the Current system and the Near Term system, the pilot must work through the specialist to get a weather briefing (except for PATWAS/TWEB capabilities). In the Far Term, direct access to the system will be available to a pilot using an interactive direct user access terminal (DUAT) which will provide route-oriented or local briefings of a variety of weather reports. If the terminal has a graphic capability, graphic products will be provided. The pilot may also access the Voice Response System using a telephone which has push-button control capabilities or utilizing the Voice Recognition Capability to request weather at specified locations. Voice Response Capabilities may be implemented as early as the Near Term depending on the results of configuration and requirement studies underway.

6.1.11 Improvements Dependencies

The most notable dependency between the improvements is the dependency of the briefing functions, the primary operational task, on the automated data base maintenance function. In fact, all the improvements are to some extent dependent on the improved data base maintenance. Improved specialist support, in the Far Term, is dependent on the improved consoles and displays as well as data maintenance automatically performed at the AWP and FSDPS. Editing functions expected to be available at the AWP will further enhance the useability of the national data base of weather and aeronautical information. Improved graphics are dependent on the availability of the AFOS data from NWS. Improved weather radar at the AFSS is dependent on the availability and remoting of the necessary radar facilities. Direct support to the pilot provided under improvements 9 and 10 are dependent on the expanded data base developed at the AWP (i.e., expanded contractions and reformatting) and on the development of the Voice Response System.

6.1.12 Potential Improvements

An Aviation Weather System Plan (Reference 6-4) is being developed under the sponsorship of FAA. Among the potential improvements to the weather system noted in this plan of special interest to the Flight Service Station system are improved weather radar capabilities and an improved weather data base under development by NWS providing for: one, more current information on upper air wind and temperatures, and two, a grid data base with up to 14 weather elements (e.g., cloud cover, bases and tops, inflight visibility, icing conditions, and turbulence) at equally distributed grid points covering the entire United States.

6.2 Flight Service Facilities Connectivity

In this section, the connections to other facilities are described, emphasizing the type of information passed over the connection. Telephone connections and connections for passing general information or administrative information are not covered. The deferred decision on whether or not to consolidate Flight Service Stations in ARTCC collocated hubs will not change the nature of the connections but will have an impact on the number and size of connections. There are three figures which illustrate the various connections over the time periods covered in this report: Figure 6-3 for the Current system, Figure 6-4 for the Near Term and Figure 6-5 for the Far Term. Each of the connections will be described below over the three time periods.

6.2.1 National Weather Service

In the Current system the National Weather Service (NWS) provides graphics charts over a facsimile channel. This capability is also available in the Near Term. In the Far Term, improved graphics products from the AFOS system under development by the NWS will be sent to the AWP via data channel. Editing and

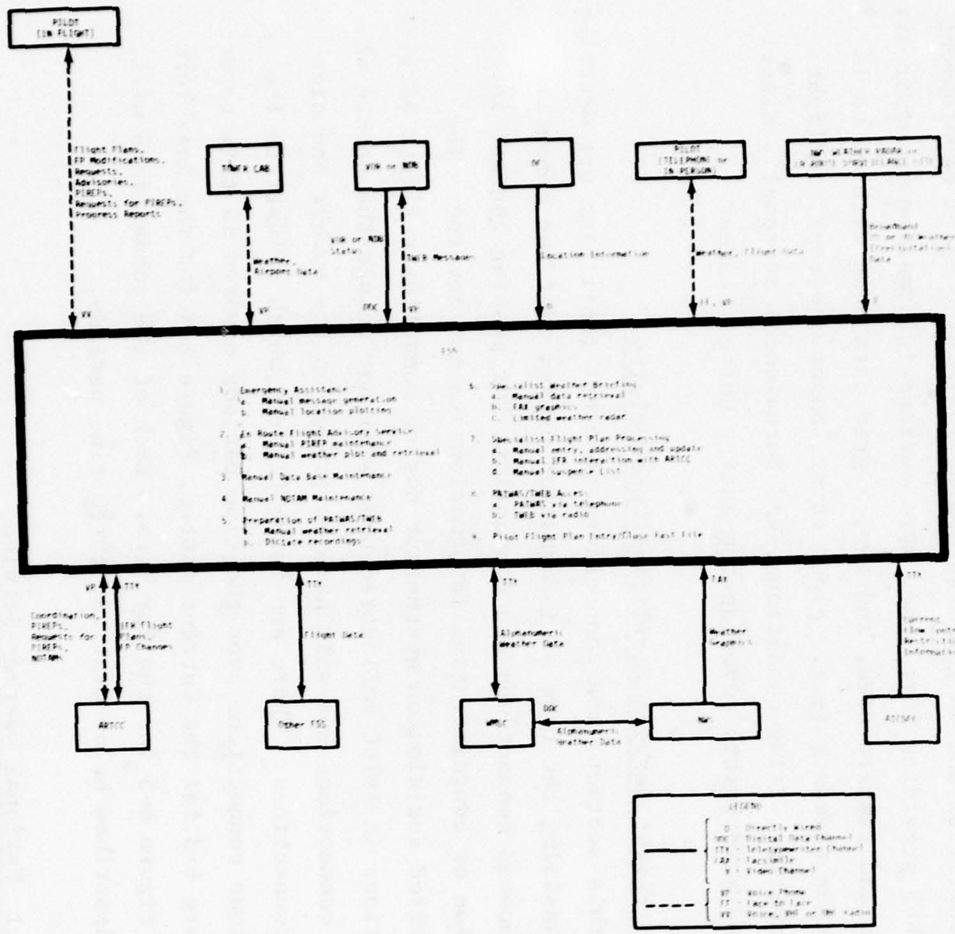
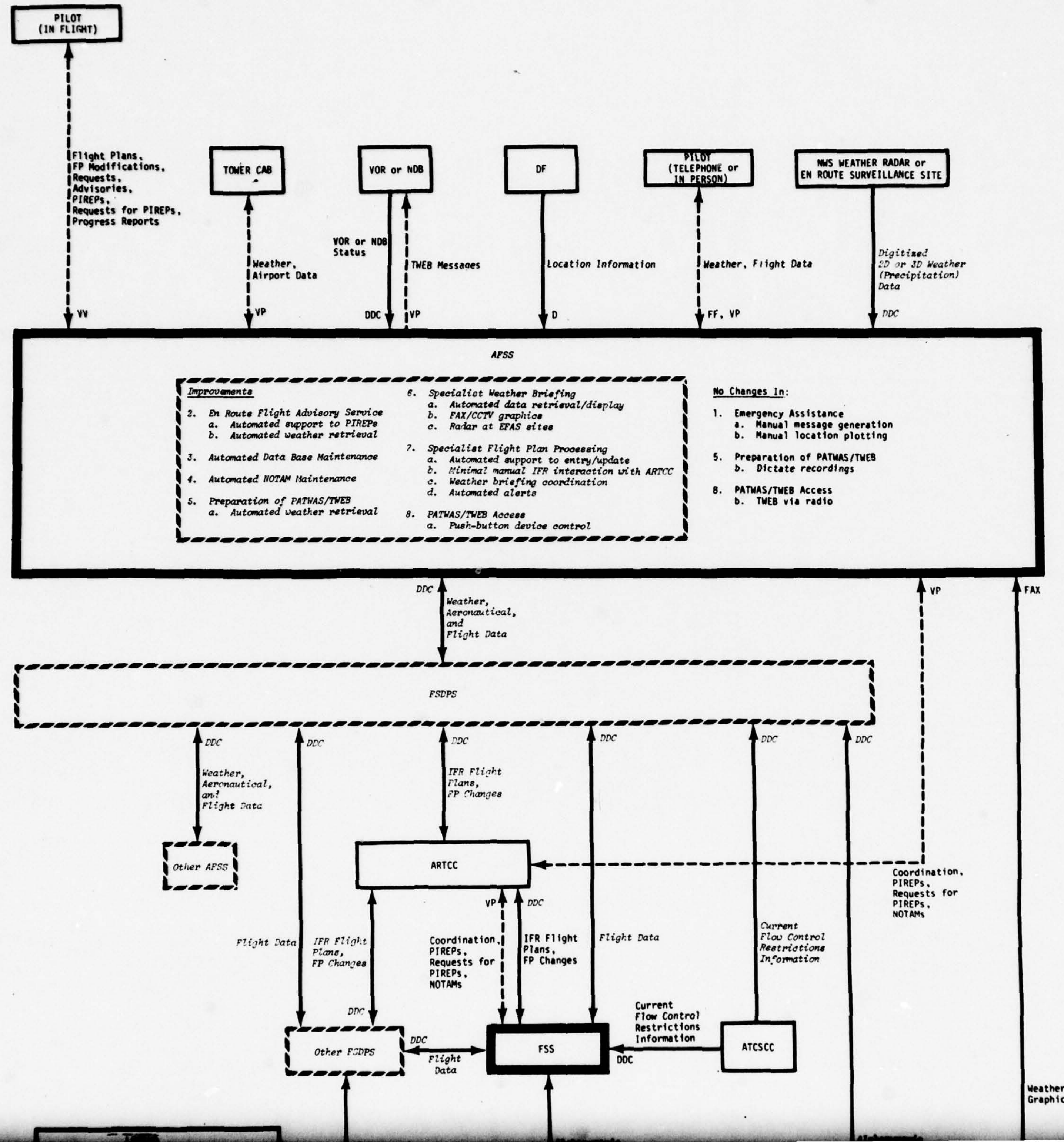


FIGURE 6-3
CURRENT FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM



PILOT
(IN FLIGHT)
Flight Plans,
FP Modifications,
Requests,
Advisories,
PIREPs,
Requests for PIREPs,
Progress Reports
VV
TOWER CAB
Weather,
Airport Data
VP
VOR or NDB
VOR or NDB
Status
DDC
TWEB Messages
VP
DF
Location Information
D
PILOT
(TELEPHONE or
IN PERSON)
Weather, Flight Data
FF, VP
NWS WEATHER RADAR or
EN ROUTE SURVEILLANCE SITE
Digitized
2D or 3D Weather
(Precipitation)
Data
DDC
AFSS
Improvements
2. En Route Flight Advisory Service
a. Automated support to PIREPs
b. Automated weather retrieval
3. Automated Data Base Maintenance
4. Automated NOTAM Maintenance
5. Preparation of PATWAS/TWEB
a. Automated weather retrieval
6. Specialist Weather Briefing
a. Automated data retrieval/display
b. FAX/CCTV graphics
c. Radar at EFAS sites
7. Specialist Flight Plan Processing
a. Automated support to entry/update
b. Minimal manual IFR interaction with ARTCC
c. Weather briefing coordination
d. Automated alerts
8. PATWAS/TWEB Access
a. Push-button device control
No Changes In:
1. Emergency Assistance
a. Manual message generation
b. Manual location plotting
5. Preparation of PATWAS/TWEB
b. Dictate recordings
8. PATWAS/TWEB Access
b. TWEB via radio
DDC
Weather,
Aeronautical,
and
Flight Data
VP
FAX
FSDPS
DDC
Weather,
Aeronautical,
and
Flight Data
Other AFSS
DDC
DDC
IFR Flight
Plans,
FP Changes
ARTCC
DDC
DDC
DDC
Coordination,
PIREPs,
Requests for
PIREPs,
NOTAMs
Flight Data
IFR Flight
Plans,
FP Changes
VP
DDC
Coordination,
PIREPs,
Requests for
PIREPs,
NOTAMs
IFR Flight
Plans,
FP Changes
Flight Data
Current
Flow Control
Restrictions
Information
DDC
Other FSDPS
DDC
Flight
Data
FSS
Current
Flow Control
Restrictions
Information
DDC
ATCSCC
Weather
Graphics

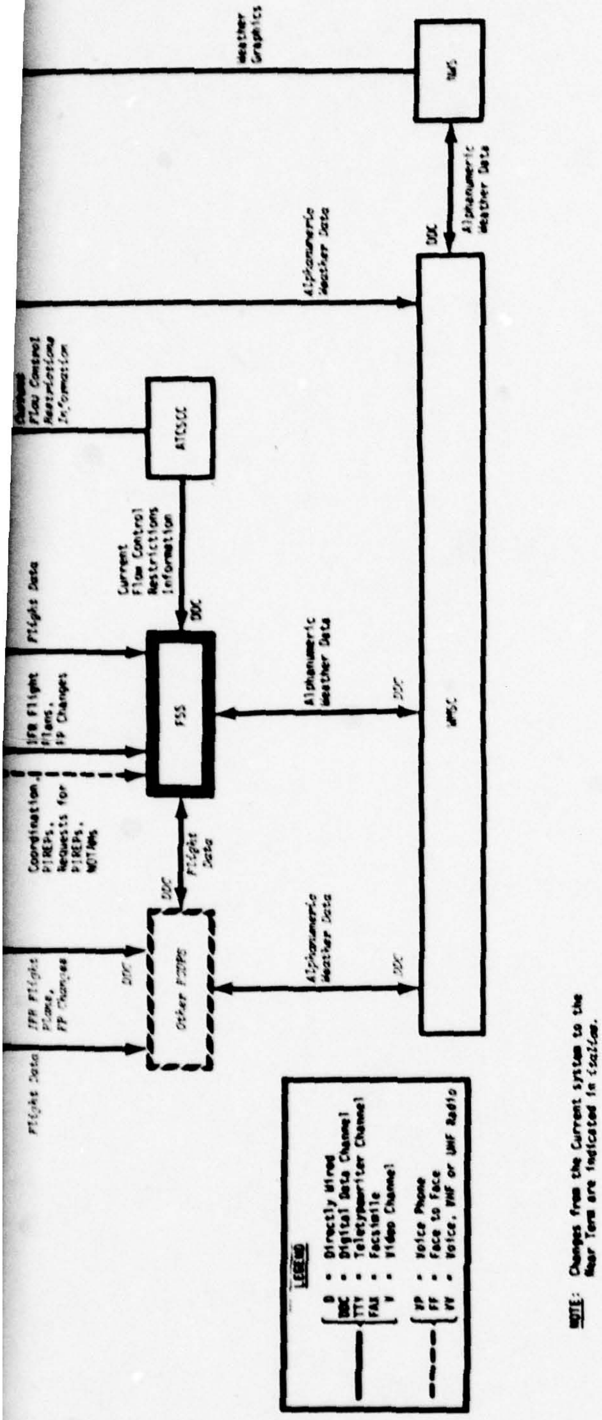
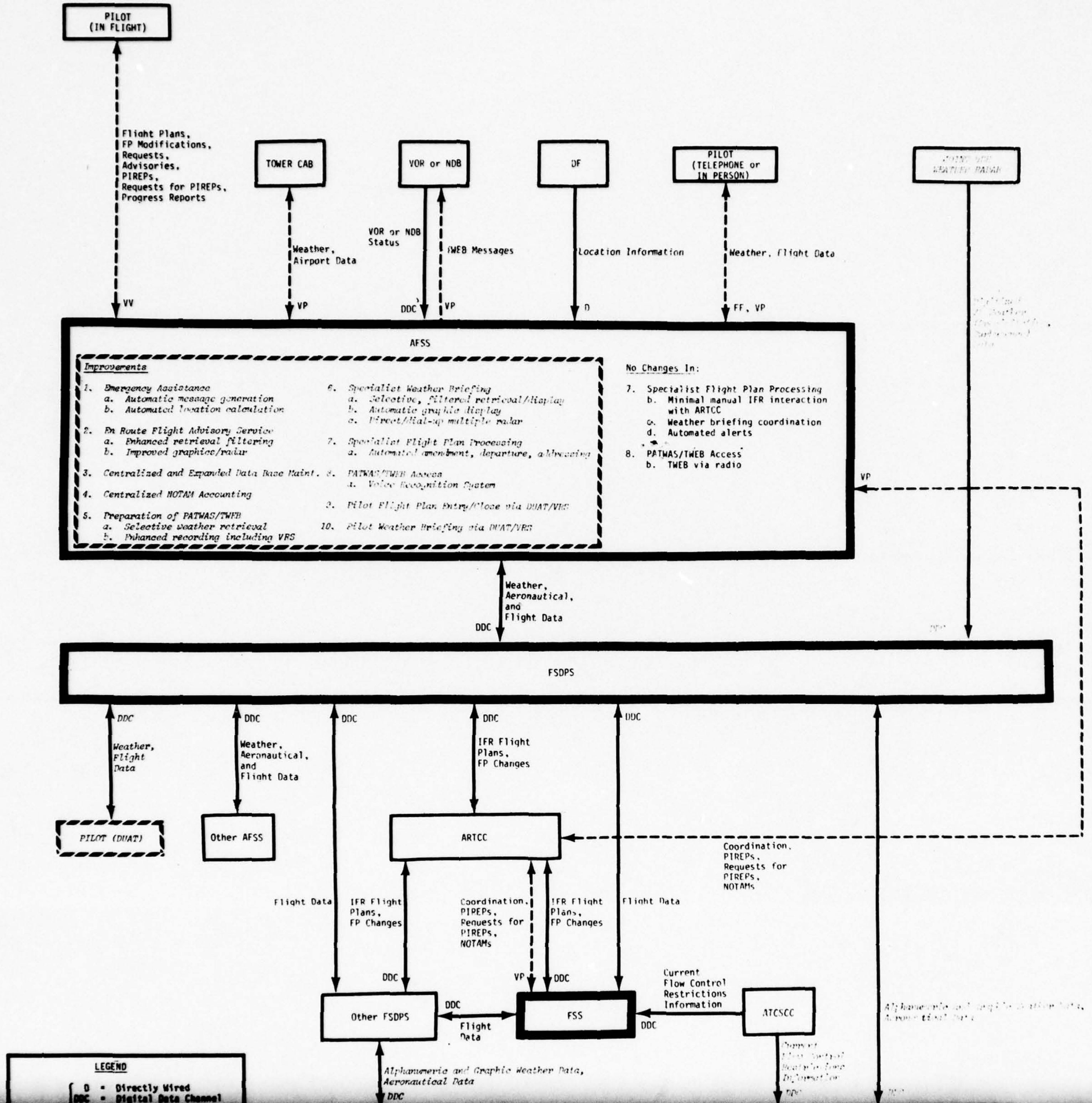


FIGURE 6-4
NEAR TERM FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM

2


PILOT (IN FLIGHT)
Flight Plans, FP Modifications, Requests, Advisories, PIREPs, Requests for PIREPs, Progress Reports
VV
TOWER CAB
Weather, Airport Data
VP
VOR or NDB
VOR or NDB Status
DDC
TWEB Messages
VP
DF
Location Information
D
PILOT (TELEPHONE or IN PERSON)
Weather, Flight Data
FF, VP
AFSS
Improvements
1. Emergency Assistance
a. Automatic message generation
b. Automated location calculation
2. En Route Flight Advisory Service
a. Enhanced retrieval filtering
b. Improved graphics/radar
3. Centralized and Expanded Data Base Maint.
4. Centralized NOTAM Accounting
5. Preparation of PATWAS/TWEB
a. Selective weather retrieval
b. Enhanced recording including VRS
6. Specialist Weather Briefing
a. Selective, filtered retrieval/display
b. Automatic graphic display
c. Direct/dial-up multiple radar
7. Specialist Flight Plan Processing
a. Automated amendment, departure, addressing
8. PATWAS/TWEB Access
a. Voice Recognition System
9. Pilot Flight Plan Entry/Close via DUAT/VRS
10. Pilot Weather Briefing via DUAT/VRS
No Changes In:
7. Specialist Flight Plan Processing
b. Minimal manual IFR interaction with ARTCC
c. Weather briefing coordination
d. Automated alerts
8. PATWAS/TWEB Access
b. TWEB via radio
VP
Weather, Aeronautical, and Flight Data
DDC
FSDPS
DDC
Weather, Flight Data
PILOT (DUAT)
DDC
Weather, Aeronautical, and Flight Data
Other AFSS
DDC
IFR Flight Plans, FP Changes
ARTCC
DDC
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Flight Data
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
IFR Flight Plans, FP Changes
Flight Data
DDC
VP
DDC
Other FSDPS
DDC
Flight Data
FSS
DDC
Current Flow Control Restrictions Information
ATCSCC
Alphanumeric and Graphic Weather Data, Aeronautical Data
DDC
LEGEND
D = Directly Wired
DDC = Digital Data Channel

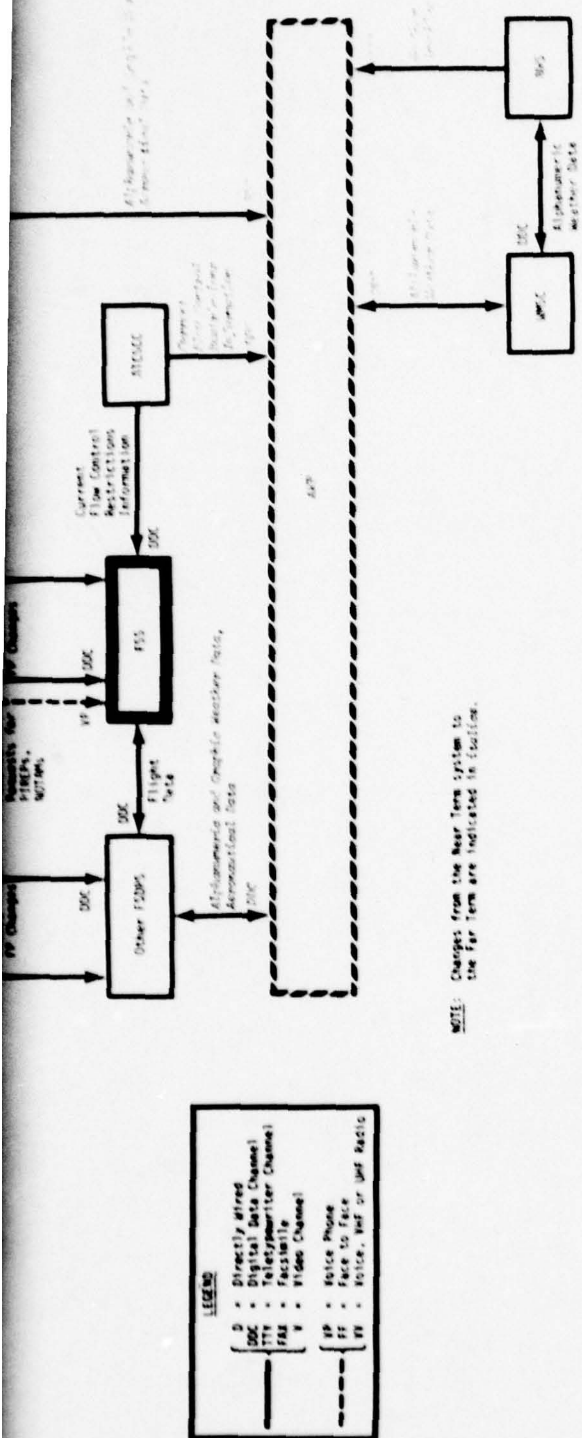


FIGURE 6-5
FAR TERM FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM

2

combining of graphic products may be performed at the AWP after which distribution to the Flight Service Data Processing Systems is made for use by the specialist at the AFSS or the pilot via DUAT.

6.2.2 Weather Message Switching Center

The Weather Message Switching Center (WMSC) gathers alphanumeric (A/N) weather and aeronautical information from a number of sources including the NWS and FSS sources. It is the primary source of such data for the Flight Service Facilities. In the Current and Near Term systems, this data is received by the Flight Service Stations over Service A teletype lines. With the adoption of NADIN II at the end of the Near Term, NADIN circuits are utilized to transmit A/N weather and aeronautical data to the FSDPSs. In the Far Term system, the data will be transmitted to the AWP via NADIN III.

6.2.3 Aviation Weather Processor

The Aviation Weather Processor is introduced in the Far Term. It receives alphanumeric weather and aeronautical information from the WMSC and graphic weather from the NWS (i.e., AFOS products). The AWP redistributes the weather and aeronautical information to the Flight Service Data Processing Systems after reformatting and expanding contractions for the alphanumeric data base to be used in pilot briefings. A plan to provide WMSC functions at two AWP (NADIN location) sites is under consideration by AAT (see Interface Adjustment, Item B:6-5).

6.2.4 Air Traffic Control Systems Command Center (ATCSCC)

In the Current system, ATCSCC messages are received at the FSSs over the Service B (or ABDIS) network. In the Near Term, a NADIN connection provides service to the FSDPSs (and FSSs). In the

Far Term a NADIN connection is established between the AWP and the ATCSCC. Air traffic restrictions are sent to the AWP over this connection for editing and retransmission to the Flight Service Data Processing System.

6.2.5 Air Route Traffic Control Center (ARTCC)

In the Current system, Service B is used to send IFR flight plans to departure ARTCCs and to send VFR flight plans to departure and destination Flight Service Stations. In the Near Term and Far Term, NADIN communications will be utilized in a similar fashion.

6.2.6 Pilot

The pilot and air crews are the users of the Flight Service Facilities. As such, information related to any of the functions described may be passed to the pilot in the form of weather briefings, flight plan handling and emergency services. In the Current and Near Term systems, the pilot is connected to the Flight Service Station via telephone, radio or face-to-face contact. In the Far Term, the pilot is able to use the system directly by means of user terminals or the Voice Response System in addition to the support from the Flight Service Specialist. Also, the pilot is a source of information of current weather conditions which enter the system as PIREPs.

6.2.7 Tower Cab

Throughout the time periods covered in this report, there is a voice connection between the Flight Service Station system and the Tower Cab for the exchange of information on airport conditions and local weather conditions and forecasts.

6.2.8 Weather Radar Surveillance Site

In the Current system, weather radar images are available in a limited number of FSSs. In the Near Term, digitized weather radar will be available at the 44 En Route Flight Advisory Service (EFAS) positions from either selected FAA ARSR radars or from NWS WSR-57 radars. In the Far Term, digital weather radar from up to 7 radars will be available on the specialist's display by request. Each FSDPS will store a weather radar image for all digitizer-equipped radars (with a maximum of 13) within the FSDPS boundaries plus 150 nautical miles.

6.3 Flight Service Facilities Information Flow

This section will describe the impact of improvements to each of the functions identified in the information flow diagrams (Figures 6-6, 6-7, and 6-8). The evolution of each function will be traced from the Current system through the Near Term system and the Far Term system. For each improvement, inputs, internal functions, outputs and operational results will be described. Changes to the flow of information over time will be described and required interface planning noted.

6.3.1 Emergency Assistance

Two aspects of emergency assistance will be described: one, assistance to an overdue aircraft, i.e., Search and Rescue (SAR) procedures, and two, assistance to a lost (disoriented) pilot. The SAR function is discussed first. In the Current system, if an aircraft becomes overdue (as noted from the inbound list) the appropriate sequence of search and rescue related messages is manually initiated. These messages are sent to the departure FSS and those FSSs along the route of flight, requesting information on the overdue aircraft and initiating a search and rescue Alert Notice as appropriate. Retrieval of data on the overdue

INPUTS

FROM PILOT:
- Flight Plans/Amendments
- Request for Assistance
- Request for Current Weather
- Pilot Reports (PIREPs)
- Request for Weather Briefing
- TWEB/PATWAS Request
- Flight Plan Closures

FROM NAVAIDS:
- Status Data

FROM DF:
- Bearing Data

FROM ARTCC:
- PIREPs
- Coordination

FROM NWS, MILITARY/FAA SOURCES (WMSC):
- Weather/Aeronautical Data Base

FROM NWS:
- FAX Graphics

FROM WEATHER RADARS SURVEILLANCE SITE:
- Weather Image

FROM OTHER FSS:
- VFR Flight Plans
- Changes, Closures
- Bearing Data
- SAR Requests

FROM TOWER CAB:
- Airport Conditions
- Local Weather

FLIGHT SERVICE STATION (FSS)
FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. Manual Message Generation
   b. Manual Location Plotting
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. Manual PIREP Maintenance
   b. Manual Weather Plot and Retrieval
3. DATA BASE MAINTENANCE
   Manual
4. NOTAM PROCESSING
   Manual NOTAM Maintenance
5. PREPARATION OF PATWAS/TWEB
   a. Manual Weather Retrieval
   b. Dictate Recordings
6. SPECIALIST WEATHER BRIEFING
   a. Manual Data Retrieval
   b. FAX Graphics
   c. Limited Weather Radar
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. Manual Entry, Addressing & Update
   b. Manual IFR Interaction with ARTCC
   d. Manual Suspense List
8. PATWAS/TWEB ACCESS
   a. PATWAS via Telephone
   b. TWEB via Radio
9. PILOT FLIGHT PLAN ENTRY
   FAST FILE

OUTPUTS

TO PILOT:
- Flight Plan Acceptance
- Location Guidance
- Current Weather
- Forecast Weather
- TWEB/PATWAS Briefing

TO OTHER FSS:
- VFR Flight Plans, Changes
- SAR Requests
- Flight Plan Closures
- Bearing Data

TO ARTCC:
- IFR Flight Plans, Changes
- Requests for PIREPs

TO DF:
- Bearing Requests

TO WMSC:
- Local Weather
- NOTAMs
- PIREPs

TO TOWER CAB:
- Weather Reports

FIGURE 6-6
CURRENT FLIGHT SERVICE FACILITIES
INFORMATION FLOW DIAGRAM

INPUTS

FROM PILOT:
- Flight Plans/Amendments
- Request for Assistance
- Request for Current Weather
- Pilot Reports (PIREPs)
- Request for Weather Briefing
- TWEB/PATWAS Request
- Flight Plan Closures

FROM NAVAIDS:
- Status Data

FROM DF:
- Bearing Data

FROM ARTCC:
- PIREPs
- Coordination

FROM NWS, MILITARY/FAA SOURCES (WMSC):
- Weather/Aeronautical Data Base

FROM NWS:
FAX Graphics

FROM WEATHER RADAR SURVEILLANCE SITE:
- *Weather Image*

FROM FSS, FSDPS:
- VFR Flight Plans, Changes
- SAR Requests
- Flight Plan Closure
- Bearing Data

FROM TOWER CAB:
- Airport Conditions
- Local Weather

AUTOMATED FLIGHT SERVICE STATION (AFSS)

FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. Manual Message Generation
   b. Manual Location Plotting
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. *Automated Support to PIREPs*
   b. *Automated Weather Retrieval*
3. DATA BASE MAINTENANCE
   Automated
4. NOTAM PROCESSING
   Automated NOTAM Maintenance
5. PREPARATION OF PATWAS/TWEB
   a. *Automated Weather Retrieval*
   b. Dictate Recording
6. SPECIALIST WEATHER BRIEFING
   a. *Automated Data Retrieval/Display*
   b. *FAX/CCTV Graphics*
   c. *Radar at EFAS Sites*
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. *Automated Support to Entry and Update*
   b. *Minimal Manual IFR Interaction with ARTCC*
   c. Weather Briefing Coordination
   d. Automated Alerts
8. PATWAS/TWEB Access
   a. *PATWAS via Push-button Control*
   b. TWEB via Radio
9. PILOT FLIGHT PLAN ENTRY FAST FILE

OUTPUTS

TO PILOT:
- Flight Plan Acceptance
- Location Guidance
- Current Weather
- Forecast Weather
- TWEB/PATWAS Briefing

TO FSS, FSDPS:
- VFR Flight Plans, Changes
- SAR Requests
- Flight Plan Closures
- Bearing Data

TO ARTCCs:
- IFR Flight Plans, Changes
- Requests for PIREPs

TO DF:
- Bearing Requests

TO WMSC:
- Local Weather
- NOTAMs
- PIREPs

TO TOWER CAB:
- Weather Reports

FIGURE 6-7
NEAR TERM FLIGHT SERVICE FACILITIES
INFORMATION FLOW DIAGRAM

INPUTS

FROM PILOT:
- Flight Plans/Amendments
- Request for Assistance
- Request for Current Weather
- Pilot Reports (PIREPs)
- Request for Weather Briefing
- TWEB/PATWAS
- Flight Plan Closures

FROM NAVAID:
- Status Data

FROM DF:
- Bearing Data

FROM ARTCC:
- PIREPs
- Coordination

FROM NWS, MILITARY/FAA SOURCES (WMSC)
- *Extended Weather/Aeronautical Data Base*
- *NOTAM Accounting Information*

FROM NWS:
- *AFOS Graphics*
- *GOES Graphics*

FROM OTHER FSS, FSDPS
- VFR Flight Plans, Changes
- SAR Requests
- Flight Plan Closure
- Bearing Data

FROM WEATHER RADAR SURVEILLANCE SITE:
- Weather Image

FROM TOWER CAB
- Airport Conditions
- Local Weather

AUTOMATED FLIGHT SERVICE STATION (AFSS)
AND FLIGHT SERVICE DATA PROCESSING
SYSTEM (FSDPS)

FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. *Automatic Message Generation*
   b. *Automated Location Calculation*
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. *Enhanced Retrieval Filtering*
   b. *Improved Graphics/Radar*
3. DATA BASE MAINTENANCE
   Automated NOTAM Accounting
4. NOTAM PROCESSING
   Centralized NOTAM Accounting
5. PREPARATION OF PATWAS/TWEB
   a. *Selective Weather Retrieval*
   b. *Enhanced Recording including Voice Response System*
6. SPECIALIST WEATHER BRIEFING
   a. *Selective, Filtered Retrieval/Display*
   b. *Automated Graphic Display*
   c. *Direct Dial-Up of Multiple Radars*
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. *Automated Amendment, Departure, Addressing*
   b. Minimal Manual IFR Interaction with ARTCC
   c. Weather Briefing Coordination
   d. Automated Alerts

DIRECT PILOT SUPPORT

8. PATWAS/TWEB ACCESS
   a. *PATWAS with Voice Recognition*
   b. *TWEB* via Radio
9. *PILOT FLIGHT PLAN ENTRY/Close*
   a. *Automated via DUAT/VRS*
10. *PILOT WEATHER BRIEFING*
    a. *Automated via DUAT/VRS*

OUTPUTS

TO PILOT:
- Flight Plan Acceptance
- Location Guidance
- Current Weather
- Forecast Weather
  - *Summary*
  - *Detailed*
- TWEB/PATWAS Briefing

TO OTHER FSS, FSDPS:
- VFR Flight Plans, Changes
- SAR Requests
- Flight Plan Closure
- Bearing Data

TO ARTCC:
- IFR Flight Plan, Changes

TO DF SITES:
- *Bearing Requests*

TO WMSC:
- Local Weather
- NOTAMs
- PIREPs

TO TOWER CAB
- Weather Reports

FIGURE 6-8
FAR TERM FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM

aircraft is manual in each of the FSSs involved and the response must be manually generated.

In the Near Term system, if an aircraft is overdue (as indicated by an automated alert), a specialist at the destination AFSS manually initiates and addresses the proper sequence of search and rescue messages. The retrieval of data on the overdue aircraft is also automatic for specialists at the departure or en route AFSS but must be manually addressed to the requesting AFSS. (Where manual Flight Services Stations are involved, their processing remains as described under the Current system.)

In the Far Term system, when an automatic alert is generated at the destination AFSS, the required search and rescue messages are automatically generated and displayed to the specialist at the destination AFSS prior to transmittal. The system will determine the addresses of other AFSSs (e.g., departure, en route) which should receive search and rescue messages. At each AFSS/FSDPS involved, requested information will be automatically retrieved and the responses automatically generated for display to a specialist prior to transmission. (Processing at manual FSSs remains as described under the Current system.)

Over time, the information flow for this function is gradually automated and communications are improved. The operational result is a more effective use of the specialist, an increased system reliability and a decreased system response time. Automated interfaces are within the Flight Services Facilities.

Assistance to a lost or disoriented pilot is provided in the Current system by utilizing the direction finder at the FSS in contact with the pilot to get a bearing which is manually plotted.

This involves manual tuning of receivers and verbal confirmation of signals. The specialist may also get other directional/locational information from the pilot (e.g., VOR radial), or time/distance checks may be done on sequential pilot transmissions to locate the pilot's position. The pilot is then given direction guidance to a safe location.

In the Near Term, the procedure is the same. In the Far Term, the specialist enters bearing information into the FSDPS which will solve the navigational problems of location and compute the heading to a requested location.

Primary inputs and outputs to the pilot remain the same; however, the support to the specialist in locating the aircraft and providing a heading to a safe location is automated. The operational effect is to provide a faster system response and more effective utilization of the specialist.

6.3.2 En Route Flight Advisory Service (EFAS)

EFAS is a specialized system providing near real-time weather service directly to pilots in flight. In the Current system, the Flight Watch Specialist (FWS) who provides the service will enter Pilot Reports (PIREPs) into the system over Service A teletype. These are then forwarded to the WMSC for entry into the national data base and subsequent distribution. The FWS will manually maintain files of PIREPs and will maintain a manual plot of current weather conditions for the area of responsibility (600 nautical mile radius of the AFSS). When the specialist is contacted by inflight pilots, they will be provided with current weather conditions. Furthermore, the FWS may contact pilots to solicit PIREPs on local weather conditions of interest and may coordinate that activity with the ARTCC responsible for that area.

In the Near Term, the input and maintenance of PIREP information is supported by the automated system at the FSDPS. PIREP entry may be made at the AFSS either in fixed or random format and the system will place the message in transmission format and send it to the WMSC. PIREP retrieval is provided by the system for specified locations and will include PIREPs received from the WMSC as well as PIREPs entered at the AFSS. As in the Current system, a manual weather plot may be maintained. This may be supplemented by automated weather retrieval in the Near Term system.

In the Far Term, the FWS will have the full range of weather retrievals available. Improved graphic products (AFOS) from NWS and weather radar displays are also expected to be available. PIREPs may be retrieved for a corridor along the route of flight or by distance from a location. Selective filtering of PIREP retrievals may be specified whereby only those PIREPs with information in selected fields (Element Indicators) will be retrieved.

Over time, the flow of information to and from the pilot remains about the same. However, the flow of information to and from the WMSC is improved by both the automated assistance to PIREP entry and the improved communication capabilities. The functions performed by the FWS are progressively automated to provide data base maintenance and retrieval as well as improved graphics products.

6.3.3 Data Base Maintenance

This function is to a large extent basic to all the others and improvements in it are reflected in the others. In the Current system, inputs to the system are over the teletype networks

(Service B for flight information and Service A for weather and NOTAMs). There is little or no automatic error checking. Data maintenance is manual and involves keeping hard copy reports organized for convenient searching and retrieval of information. Graphic products are available by facsimile network from NWS. In the Near Term, automated support is provided for the input of information and for maintenance (update) of the data base. Most specialist inputs are in either fixed or variable format, error checking is performed, new weather inputs from WMSC replace outdated weather in the data base.

In the Far Term data base maintenance functions for the Flight Service Automation System are shared between the Aviation Weather Processor (AWP) and the Flight Service Data Processing Systems (FSDPSs).

6.3.3.1 AWP Data Base Maintenance

In the Far Term, weather and aeronautical information from WMSC is received at the AWP where a number of centralized processes are performed. Reformatting of the information and expansion of contractions is automatically done for the weather and aeronautical data base to be used in support of pilot briefings (e.g., via DUATs). Surface Observations and Pilot Reports are reformatted but all other messages from WMSC are utilized as received (except for manual editing) for the data base to be used in support of the FSS specialists. Graphic data from the NWS AFOS system is also received at the AWP. Manual editing including manual entry of graphics is planned for the AWP. Centralized maintenance is also performed at the AWP on Preferred Routes, the Law Enforcement file and Special Use Areas. Periodic data base updates are sent to the FSDPSs and a complete data base is supplied when needed (e.g., start-up).

6.3.3.2 FSDPS Data Base Maintenance

Data base maintenance except for local inputs is automatic at the FSDPSs in the Far Term. As new information is received from the AWP it automatically replaces older data. Weather radar inputs are maintained for up to 13 radar sites and up to seven radar images are automatically redistributed to each AFSSs when updates are received or the AFSS requires it. Graphics (e.g., AFOS products) are also automatically maintained at the FSDPSs and redistributed to the AFSSs.

6.3.4 NOTAM Processing

NAVAID monitoring and control is performed at the Flight Service Station by monitoring a status panel and by switching in alternate NAVAIDs as needed. The Flight Service Stations are the prime source of entry of the Notices to Airmen (NOTAM) into the national aviation data base. When outages occur or are reported in the Current system, the specialist enters the information into the teletype system and manually maintains a file for local use. This requires strict manual accounting procedures and lists to insure data integrity. In the Near Term and Far Term, automated support is provided to the entry and distribution of NOTAMs. As the specialist receives notification of airport conditions or determines NAVAID outages, the information is entered in the format provided by the computer. The program will automatically assign the accountability location and the sequential serial number for that location, and will transmit the NOTAM to the WMSC for nationwide distribution. In both the Near Term and Far Term, the specialist may enter a suspense time when the computer program will recall the NOTAM for appropriate follow-on action (e.g., reentry, cancellation). In the Far Term, automated NOTAM accounting will be provided and NAVAID status information is expected to be provided by the Remote Monitoring and Maintenance System (RMMS).

6.3.5 Preparation of PATWAS/TWEB

In the Current system, weather and aeronautical information retrieval for recording Pilot Automatic Telephone Weather Answering Service (PATWAS) and Transcribed Weather Broadcast (TWEB) is done manually by the specialist. TWEB reports or TWEB synopsis from NWS may be used along with PIREPs, NOTAMs and other information as appropriate. The specialist dictates into the recording mechanism, the specific weather report compiled for each PATWAS and TWEB outlet. Generally the emphasis is on current weather or developing inclement conditions. In the Near Term system, weather retrieval for use in PATWAS and TWEB recording is done by the system which may utilize prespecified sequences of weather and aeronautical messages by specified location or locations (which can define PATWAS or TWEB routes) or weather reports may be retrieved by location or route. The predefined sequences may specify appropriate combinations of prepared text messages and current weather messages for the respective PATWAS or TWEB routes in order to present to the specialist all required information for each PATWAS or TWEB report. The specialist then uses this information to record the reports as in the Current system. The number of reports available to the pilot is to be expanded for the Near Term and Far Term. In the Far Term system, weather and aeronautical information retrieval can be route-oriented or by location and can be prespecified as in the Near Term system. The capability to retrieve weather and aeronautical information tailored to the specific formats and data to be entered into the PATWAS and TWEB recordings would be available. Once the required information is retrieved, individual reports need to be recorded only once and the system will enter that report in all routes which contain it. Selective changes to a report would be possible. Individual reports would be automatically entered into the

PATWAS/TWEB by the Voice Response System with editing by the specialist where ambiguous meanings occur (e.g., the expansion of contractions).

Over time, increasing automated support is provided to the specialist in preparing PATWAS and TWEB recordings by first automating the retrieval of weather and aeronautical information, second automating the recording function by distribution of reports into all affected recordings, and third by the introduction of support from the Voice Response System.

6.3.6 Specialist Weather Briefing

The weather briefing function draws on a large data base of weather and aeronautical information. Table 6-2 lists the general categories of information.

In the Current system, the specialist must search through files of teletype reports or recall weather conditions in order to present a weather briefing to a pilot. The teletype reports of weather and aeronautical conditions are manually searched for information of importance to the pilot for the particular flight being planned. Graphic products available to the specialist are received from the NWS over a facsimile network. Weather radar displays are available in a limited number of FSSs. In the Near Term system, retrieval of weather and aeronautical conditions from the data base is automated and can be by predefined sequences of message types, by specific location and weather type, or can be area or route-oriented. The retrieved information is presented to the specialist on a display. Graphic products from NWS are made available more conveniently using closed circuit television. Weather radar is available at a limited number of AFSSs (e.g., the 44 EFAS

TABLE 6-2
WEATHER AND AERONAUTICAL INFORMATION CATEGORIES

- Surface Aviation Weather Observations (Domestic, Military, Canadian, Mexican, Caribbean, Alaskan)
- Aviation Terminal Forecasts (Domestic, Military, Canadian, Mexican and Caribbean)
- Notices to Airmen (NOTAMs)
- FDC NOTAMs AND FDC NOTAM Cancellations
- CARF NOTAMs AND CARF NOTAM Cancellations
- International NOTAMs
- Area Forecasts (Domestic, Canadian, Mexican and Caribbean)
- Significant Meteorological Information
- Airmen's Meteorological Information
- Pilot Reports (Domestic, Alaskan)
- TWEB Routes and Synopses
- Hurricane Advisories
- Severe Weather Forecasts and Bulletins
- Severe Weather Outlook
- Grid Winds
- Radar Reports (Domestic, Canadian, Caribbean)
- ATC System Command Center (ATCSCC) Messages
- Military Operations Messages
- AFOS Graphic Products
- Tropical Depression Advisories
- Prognostic Map Discussion

positions). In the Far Term, the retrieval of weather and aeronautical conditions for the specialist is even more flexible and more selective. Route-oriented briefings may utilize preferred routes available from the system, filtering of reports on the basis of weather conditions is utilized (i.e., if there are no significant weather phenomena the report is not displayed). Graphic displays (including AFOS products) would be retrieved from the data base as well as weather radar displays; these would be viewed on a separate video terminal by the specialist.

The automation of weather and aeronautical data retrieval and display to the specialist is progressively improved to be more flexible and increasingly selective in order to provide the needed information more quickly and with the minimum amount of excess information.

6.3.7 Specialist Flight Plan Processing

In the Current system, when a specialist receives required information from a pilot wishing to file a flight plan, the specialist will note the information while talking to the pilot. The flight plan is then entered into the Service B teletype network in a highly structured format and addressed to the destination FSS if it is VFR or to the departure ARTCC if it is IFR. Error notifications or rejections from the addressees must be corrected in the same structured format and addressed to the specific locations. Subsequent amendment, departure and flight plan close messages must be entered in a similar fashion. Coordination with ARTCCs is accomplished via telephone or utilizing the manual process described above. In the Near Term system, the specialist will request a flight plan format on the video terminal when a pilot requests assistance in filing a flight plan. As the pilot gives

information to the specialist, the specialist will enter it in the proper fields until the required information is complete. The specialist will then indicate whether the flight plan is to be transmitted to an ARTCC (for IFR flights) or sent to the destination facility when activated (in the case of VFR). In the Near Term and Far Term, flight plan information entered in the process of a weather briefing will be retained temporarily by the system for use in building a flight plan message so such information will not have to be reentered.

In the Current system a list of incoming flights is manually maintained by the specialist and is used to determine if flights are overdue. In the Near Term and Far Term systems, the list of incoming flights is automatically maintained by the system. Flights that are overdue (i.e., not closed or cancelled, within a specified time of expected arrival) will cause an automatic system alert at a specialist position.

In the Far Term system, such alerts will also cause the system to prepare Search and Rescue message for review and possible use by the specialist.

6.3.8 PATWAS/TWEB Access

In the Current system, PATWAS access is via telephone. The pilot must dial the specific number to get the local or PATWAS route information wishes. In the Near Term and Far Term systems, one telephone number will have a selection of routes or local briefings available by utilizing push-button control. In the Far Term, PATWAS access may also utilize a Voice Recognition System. TWEB access is available via radio throughout the time periods covered.

6.3.9 Pilot Flight Plan Entry/Close

In the Current and Near Term systems, the pilot does not have direct access to the system for filing or closing flight plans. The pilot may, however, utilize the Fast File capability which will record flight plan information for subsequent entry into the system by a specialist. In the Far Term system, the pilot may use a DUAT or may enter flight plans utilizing the Voice Response System. On a DUAT, entries are made in a conversational mode, and if the filing is in conjunction with a weather briefing, flight plan information entered during the course of the weather briefing is retained temporarily by the system and is available to the pilot to use without reentry. If the Voice Response System is used in conjunction with entries on a push-button equipped telephone, the system will echo each elements of the flight plan entered by the pilot for confirmation or correction. Also the DUAT may be used for cancelling or closing a flight plan. Flight data entered into the system by a pilot is transmitted to the departure ARTCC in the case of IFR and to the departure and arrival AFSS in the case of VFR.

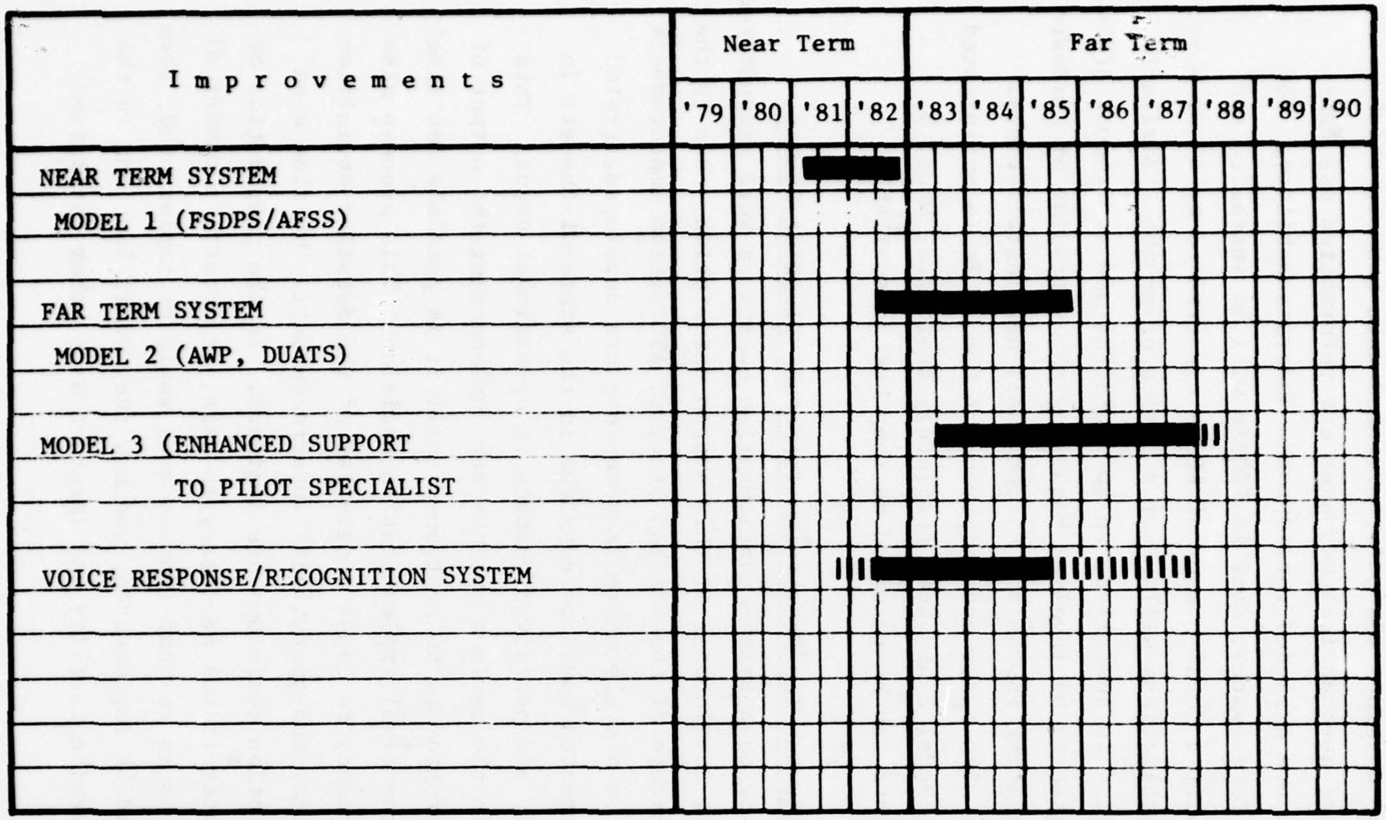
6.3.10 Pilot Weather Briefing

Except for PATWAS (and TWEB) the pilot does not have direct access to the system for a weather briefing until the Far Term. In the Far Term system, a Direct User Access Device (DUAT) may be used by a pilot to carry out an interactive session with the FSPDS to get a briefing on weather and aeronautical information either on a route-oriented or specific location basis. If the DUAT is capable of displaying graphics, appropriate graphics will be presented as part of the briefing. If not, area forecasts will be displayed for the indicated route of flight. Alternatively, a pilot may use push-button equipped telephone

to request local or route-oriented briefings from the Voice Response System. Pilot briefings are presented by the system utilizing the special data base in which weather and aeronautical messages have been reformatted and contractions have expanded. The Voice Response capabilities described under the Far Term are being pursued independent of any specific FSAS model and could be implemented as early as the Near Term, depending on the results of configuration and requirement studies underway.

6.4 Flight Services Facilities Tentative Implementation Schedule

Figure 6-9 shows a tentative implementation schedule derived from Reference 6-1. The completion of proposal requests, governmental review processes, and the negotiation of contracts to develop and implement the required capabilities may modify these schedules. The Near Term system, Model 1, begins the process of automating Flight Service Stations with emphasis on automated support to the specialist both for the entry and retrieval of information and for automated data base maintenance. In the Far Term, which includes Model 2 and Model 3, automation of specialist support is extended by the provision of more extensive and selective retrieval capabilities, improved graphics and improved displays and terminals. Direct support to the pilot provides for access to the system utilizing the Direct User Access Terminal (DUAT) or via telephone to the Voice Response System (VRS). The analysis and development of Voice Response capabilities and Voice Recognition features is proceeding independent of specific automation models, e.g., Voice Response capabilities are being developed for implementation as soon as possible. Possible changes in or extensions to schedules are indicated by the broken bars. Data base maintenance is further automated in the Far Term with the provision of the Aviation Weather Processor (AWP)



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 6-9

FLIGHT SERVICE FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE

which also develops the pilot oriented data base in which weather and aeronautical messages are reformatted and contractions are expanded for improved understandability. For the Near Term system, some 14 FSDPSs will be installed and will support a total number of AFSSs expected to be 43 or more. These installations will cover a period of months. Similarly, when Model 2 is installed, up to 20 FSDPSs and additional AFSSs are expected to be involved requiring the upgrading of hardware in the existing FSDPSs and 6 (optional) new installations. This will also occur over a period of time. It is anticipated that once Model 2 has been completely installed, Model 3 enhancements can be released as they become available.

6.5 Flight Service Facilities Interface Planning Summary

A number of open system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in the various options for implementing the output of the E&D program to be kept open until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, and how they would function in the flight service facility and interact with other facilities.

This section identifies assumption and areas of uncertainty by what are called "Open Items" and Interface Adjustments."

6.5.1 Open Items

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&D and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, an Open Item involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the flight service facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for flight service facilities. Instead, it might be contained within the program of another interfacing facility. The Open Items pertinent to flight service facilities are:

Open Item 15: Voice Communications Planning

1. Air-ground-air communication for the ARTCCs and major terminals will be upgraded in the post-1982 time period by implementation of the radio portion of VSCS, which would be referred to as RCCS. In the near term, RCAG tone control equipment for the ARTCCs will be replaced, possibly with a modular subsystem that would be compatible with longer term RCCS/VSCS designs. The FSSs, which are assumed to remain unconsolidated, will continue to use switching and control

equipment based on existing designs. In addition, the transmitters, receivers, and antenna systems at all FAA ground sites will be replaced with modern design equipment.

2. Ground-ground communications would be modernized by the implementation of ground-ground portions of the VSCS system which would replace the WECO 300 system at ARTCCs, and the WECO 301 system at the larger terminals. The existing small key systems and call distributors at FSSs would remain in place.

3. At some smaller terminals, a Small Voice Switching System (SVSS) will be implemented, which will provide an integrated radio and ground voice communications capability.

Open Item 16: FSS Modernization and NADIN Communication Schedule Compatibility

1. Implementation of NADIN I will begin in early 1981 and will not be operational in time to initially provide the expanded data communications capability required for the Model 1 FSS improvements that will also be implemented starting in early 1981. Interim data communication capability for FSS Model 1 will be provided by the Area B (ABDIS) and Service A networks, with NADIN I eventually replacing Area B.

2. Implementation of NADIN II will begin in early 1982 and will be operational in time to provide the additional expansion of the data communication capability that is needed to support Model 2 FSS improvements that will begin implementation in early 1983.

3. Implementation of NADIN III will begin in late 1982 and will be operational in time to provide the added data communication features needed to support the FSS Aviation Weather Processor that will become operational in early 1983.

Open Item 21: Automated Flight Service Station Configuration

The Flight Service Station automation program will result in a configuration of Automated FSSs as well as a number of manual FSSs through the Far Term (post 1982). The Automated FSSs (AFSSs) will be provided centralized support by up to 20 Flight Service Data Processing Systems (FSDPSs) collocated at existing ARTCCs. Each FSDPS will provide support for a number of AFSSs. In the Far Term, a centralized Aviation Weather Processor (AWP) will process weather and aeronautical data received from the Weather Message Switching Center prior to distribution to the FSDPSs. This data will be reformatted and a second data base developed with contractions expanded for providing direct service to pilots or other users accessing the FSDPSs via Direct User Access Terminals (DUATs). Graphic products received at the AWP from NWS will also be maintained and edited at the AWP prior to distribution to the FSDSPs. Each FSDPS will, additionally, receive radar images from up to 13 radar sites (FAA or NWS). Graphic products and radar images will be redistributed to the AFSSs for quick availability to the specialists at the AFSSs.

6.5.2 Interface Adjustments

This section identified some fairly specific smaller scale interface uncertainties. These uncertainties generally involve minor

design modifications in one or more programs that are not considered as significant as the previously cited Open Item. The Interface Adjustments pertinent to the Flight Service Facilities chapter are:

Interface Adjustment B6-1 -- ARTCC/FSH-AFSS PIREP Acquisition Coordination

An automated interface appears in the FSS System Description between the ARTCCs and the AFSS to support the acquisition of PIREPs. Such an interface is not included in the FSS Model 2 specification. The requirement needs to be reviewed and the interface defined depending on the results of the consolidation decision to be made by 1983.

Interface Adjustment B6-2 -- RCCS/FSH-AFSS Interface

An RCCS facility is shown in the Master Plan under the consolidated FSH alternative. Current planning assumes the unconsolidated alternative, leaving the RCCS requirement undefined.

Interface Adjustment B6-3 -- AV-AWOS/FSDPS Interface

The Aviation Automated Weather Observation System (AV-AWOS) under NWS development will interface with the Flight Service Data Processing Systems (FSDPSs). This development should continue to be monitored in order to develop the details of the interface.

Interface Adjustment B6-4 -- FSDPS/Weather Radar Interface

If a new doppler weather radar being developed by a joint FAA/NWS/AF effort is successful, it will be desirable to supply digitized inputs from the radars to the Flight

Service Station Facilities. This radar is expected to detect turbulence as well as precipitation.

Interface Adjustment B6-5 -- AWP-WMSC Combined Function

A plan is being considered to provide WMSC data base maintenance and retrieval functions at two AWP locations. Such a development would require revisions to the existing or currently planned interfaces with AWP and WMSC users.

7. SURVEILLANCE FACILITIES

This chapter describes the facilities that provide surveillance information on aircraft and the weather for use by the en route and terminal ATC facilities. The use of search radars (ASR's, ARSRs) and beacon systems (ATCRBS, DABS) to provide surveillance information is discussed as well as surveillance data preprocessing performed at the surveillance sites. In addition, the utilization of separate three dimensional weather radars to provide weather data and the utilization of ATARS Processors to automatically generate pilot advisories to prevent midair collisions is also discussed.

First, the anticipated Near Term and Far Term improvements for the en route surveillance sites are described in Section 7.1. Then, a similar description of terminal surveillance sites improvements is presented in Section 7.2. This, in turn, is followed in Section 7.3 by a summary of the major assumptions that were made with regard to interfaces with other ATC facilities and the time phasing of the various surveillance improvements.

7.1 En Route Surveillance Sites

This section briefly summarizes the functions currently performed at a typical en route surveillance site, and the anticipated Near Term and Far Term improvements; gives a more detailed description of the anticipated functional and connectivity changes due to these improvements; and briefly discusses the tentative time phasing of these improvements.

7.1.1 En Route Surveillance Site Improvements Summary

Table 7-1 lists the major functions currently performed at a typical en route surveillance site. The en route search

TABLE 7-1
CURRENT EN ROUTE SURVEILLANCE SITE FUNCTIONS AND EQUIPMENT

FUNCTIONS	EQUIPMENT	
1. SEARCH RADAR		
• PULSE TRANSMISSION	L-BAND TRANSMITTER	ARSR
• TARGET DETECTION AND THE REJECTION OF CLUTTER	L-BAND RECEIVER, MOVING TARGET INDICATOR (MTI)	ARSR
2. BEACON		
• ATCRBS INTERROGATIONS	ATCRBS TRANSMITTERS	ATCBI
• REPLY DETECTION	ATCRBS RECEIVER	ATCBI
3. SURVEILLANCE DATA PREPROCESSING		
• TARGET DATA QUANTIZATION AND THE CORRELATION OF SEARCH RADAR AND BEACON INTERROGATOR DATA	COMMON DIGITIZER (CD)	
• WEATHER (PRECIPITATION) DETECTION AND QUANTIZATION	WEATHER FIXED MAP UNIT (WFMU)	

radar, also referred to as an Air Route Surveillance Radar or ARSR, depends solely upon electromagnetic reflections for its surveillance information. Each ARSR has a directional antenna which rotates 360° every 10 to 12 seconds while the ARSR transmits a stream of L band pulses and detects and processes the L band returns. Included in this processing is the utilization of Moving Target Indicator (MTI) circuitry to detect moving targets and reject background clutter due to electromagnetic reflections from the surrounding terrain.

The Beacon Interrogator, also referred to as an Air Traffic Control Beacon Interrogator or ATCBI, has a directional antenna which rotates with the ARSR antenna on the same pedestal. The ATCBI interrogates an aircraft's ATCRBS transponder to obtain altitude and identity information, and detects the transponder's reply.

Surveillance data preprocessing is performed by the Common Digitizer (CD) which:

- Converts the broadband (video) surveillance information from the ARSR and the ATCBI into digital data;
- Combines the numerous replies received from each aircraft during a single antenna scan; and
- Correlates the combined ARSR data on each aircraft with the combined ATCBI data to produce a single target report on each aircraft (range, azimuth, altitude and identity) for each antenna scan.

The Weather Fixed Map Unit (WFMU) utilizes the ARSR returns to detect precipitation and converts this video information into

digital information defining two precipitation levels (low and high). The digitized aircraft target reports and the weather data are combined in the CD and sent to the ARTCC over telephone lines as narrowband (digital) data. As a back-up, broadband (video) data is sent over a Radar Microwave Link (RML) to the ARTCC.

Having briefly described the functions performed at a current en route surveillance site, an overview of the Near Term and Far Term improvements at each site, listed in Table 7-2, will now be presented.

In the Near Term (1979-1982), four significant improvements are anticipated.

- The replacement of some vacuum tube ARSR-1s with solid state ARSR-3s to improve equipment reliability and maintainability. ARSR-3s are also being installed at other locations to provide additional surveillance coverage.

- The utilization of the existing NWS Weather Radars to provide three-dimensional weather (precipitation) information for some ARTCCs, FSSs, and Automated FSSs (AFSSs).

- The replacement of the Common Digitizer with a Dual Common Digitizer (CD-2) to improve site reliability, since it is the only subsystem at an en route surveillance site that is not redundant at the present time. This is particularly important since the FAA is rapidly moving toward 24-hour-a-day operation of its automated equipment at an ARTCC.

TABLE 7-2
EN ROUTE SURVEILLANCE SITE IMPROVEMENTS

FUNCTIONS	CURRENT SYSTEMS (1978)	NEAR TERM IMPROVEMENTS (1979-1982)	FAR TERM IMPROVEMENTS (Post-1982)
1. SEARCH RADAR			
• TARGET DETECTION AND THE REJECTION OF CLUTTER	MTI	NC	MTD
• WEATHER DETECTION	NWS WEATHER RADAR (ANALOG: FSS)	NWS WEATHER RADAR (DIGITAL: AFSS, ARTCC)	ARSR WEATHER CHANNEL, JOINT USE WEATHER RADAR
• EQUIPMENT RELIABILITY AND MAINTAINABILITY	ARSR-1,-2	ARSR-3*	ARSR-4, RMMS
2. BEACON INTERROGATOR			
• INTERROGATION	ATCRBS TRANSMITTER	NC	DABS TRANSMITTER
• REPLY DETECTION	ATCRBS RECEIVER	NC	DABS RECEIVER
• GROUND TO AIR TO GROUND DIGITAL DATA LINK	NA	NA	DABS DATA LINK
• EQUIPMENT RELIABILITY AND MAINTAINABILITY	ATCBI-3,-4,-5	NC	DABS, RMMS
3. SURVEILLANCE DATA PREPROCESSING			
• TARGET DATA QUANTIZATION AND THE CORRELATION OF SEARCH RADAR AND BEACON INTERROGATOR DATA	COMMON DIGITIZER	CD-2*	DABS PROCESSOR
• WEATHER DETECTION AND QUANTIZATION	VFMU	CD-2*	AUTOMATIC DETECTION OF TURBULENCE
4. AUTOMATIC TRAFFIC ADVISORY AND RESOLUTION SERVICE (ATARS)	NA	NA	ATARS PROCESSOR

NC = NO CHANGE INCLUDED IN CURRENT PLANS

NA = NOT APPLICABLE

* = APPROVED BY THE FAA FOR IMPLEMENTATION

- The replacement of the WFMU with circuitry within the CD-2 to improve the quality of the digitzed weather data forwarded to the ARTCCs and some FSSs or AFSSs.

In the Far Term (post 1982), ten significant improvements are tentatively being considered by the FAA.

- The replacement of MTI circuitry in all ARSRs with Moving Target Detectors (MTDs) which would improve the detection of aircraft in heavy clutter.

- The installation of a separate weather (receiver) channel in some ARSRs to improve the quality of the weather data received.

- The installation of a separate Joint Use Weather Radar network to improve the quality of the weather data used jointly by the FAA, the National Weather Service (NWS), and the USAF's Air Weather Service (AWS).

- The utilization of the 3D weather data from each Joint Use Weather Radar to automatically detect turbulence and to forecast its movement 10 to 20 minutes into the future.

- The replacement of vacuum tube ARSR-1s, -2s with solid state ARSR-4s, thereby improving equipment reliability and maintainability.

- The installation of the Discrete Address Beacon System (DABS) with its discrete address capability which would provide the means for a ground to air to ground digital data link.

- The replacement of the CD-2 with its sliding window detector with DABS monopulse detection and processing, thereby reducing the number of ATCRBS and DABS interrogations per scan.

- The replacement of vacuum tube ATCBI-3s with DABS to improve equipment reliability and maintainability.

- The installation of ATARS Processors to automatically generate pilot advisories to prevent midair collisions.

- The installation of the Remote Maintenance Monitor System (RMMS) to monitor the performance of the equipment at the site and forward this information to the ARTCC (see Chapter 2 for a discussion of RMMS).

7.1.2 En Route Surveillance Site System Connectivity

Figures 7-1, 7-2, and 7-3 illustrate the current connections between an en route surveillance site and other ATC facilities and the anticipated changes in these connections due to the Near Term and Far Term improvements.

There are two significant changes in connectivity when the Near Term improvements are implemented.

- After the CD-2s are installed at the en route surveillance sites and the Direct Access Radar Channels (DARCs) are installed at the ARTCCs, the backup broadband surveillance data will probably be eliminated.

- Digitized weather data will probably be sent from the En Route Surveillance Sites and existing NWS Weather Radars to some ARTCCs, FSSs and AFSSs.

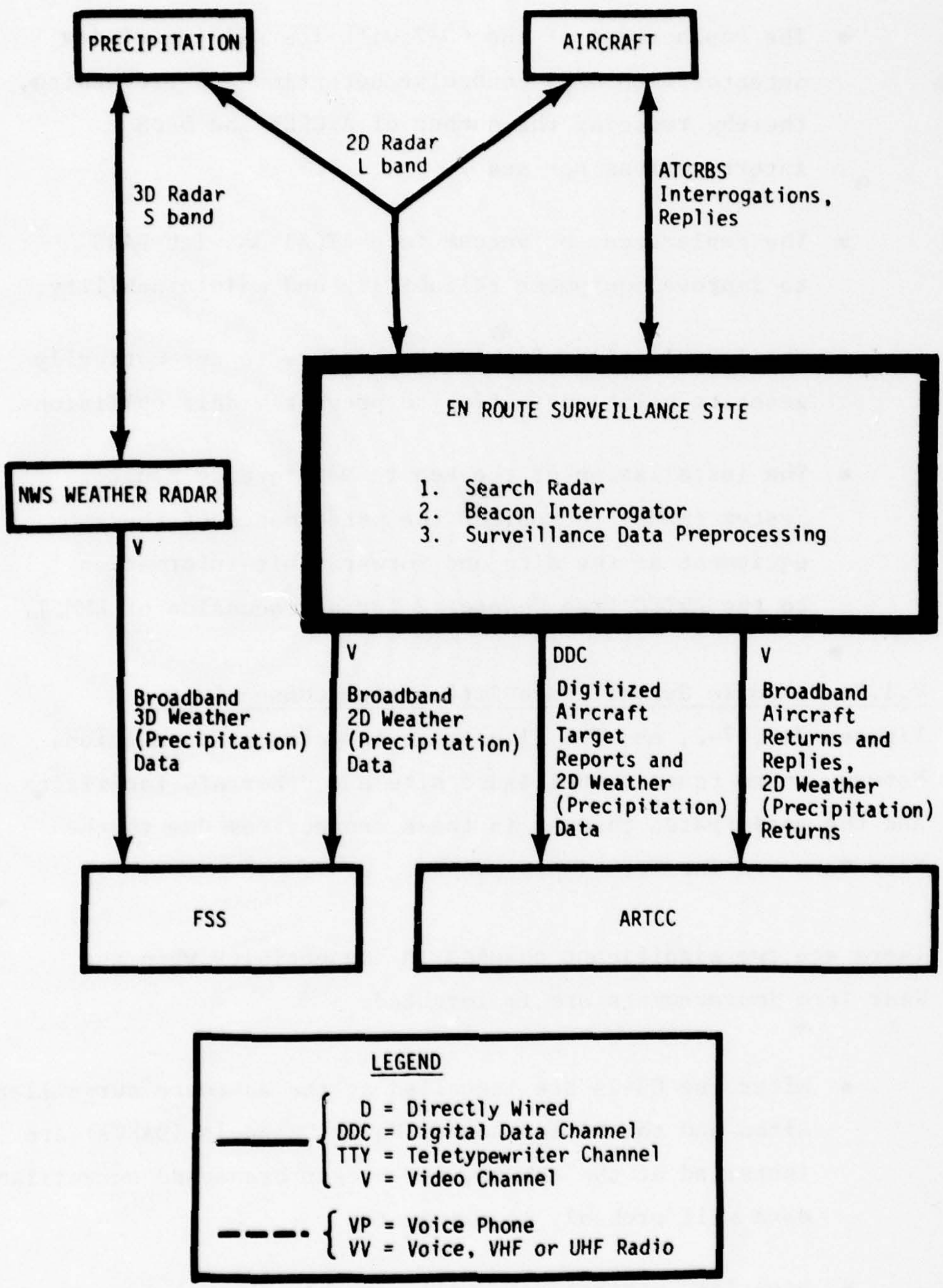
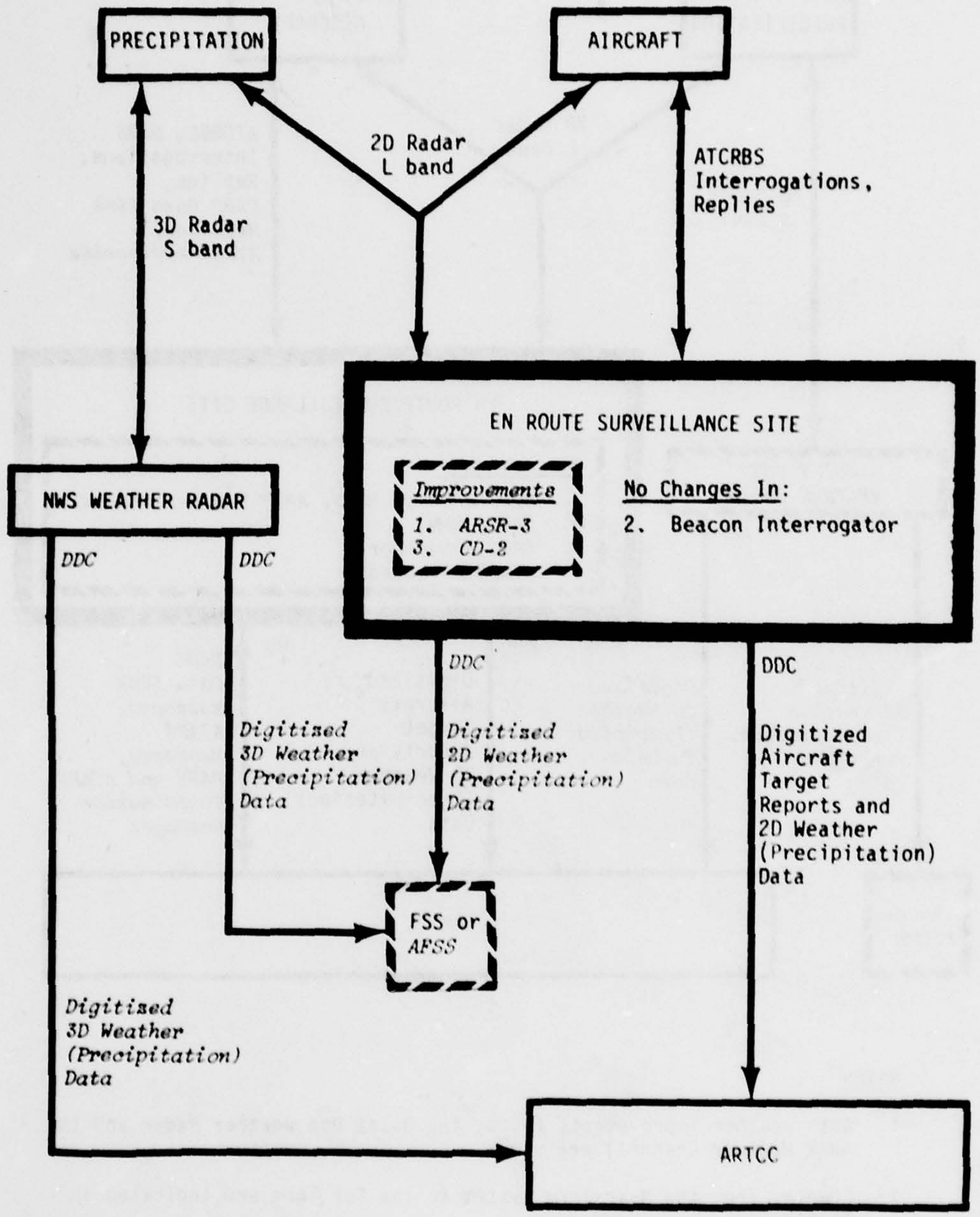
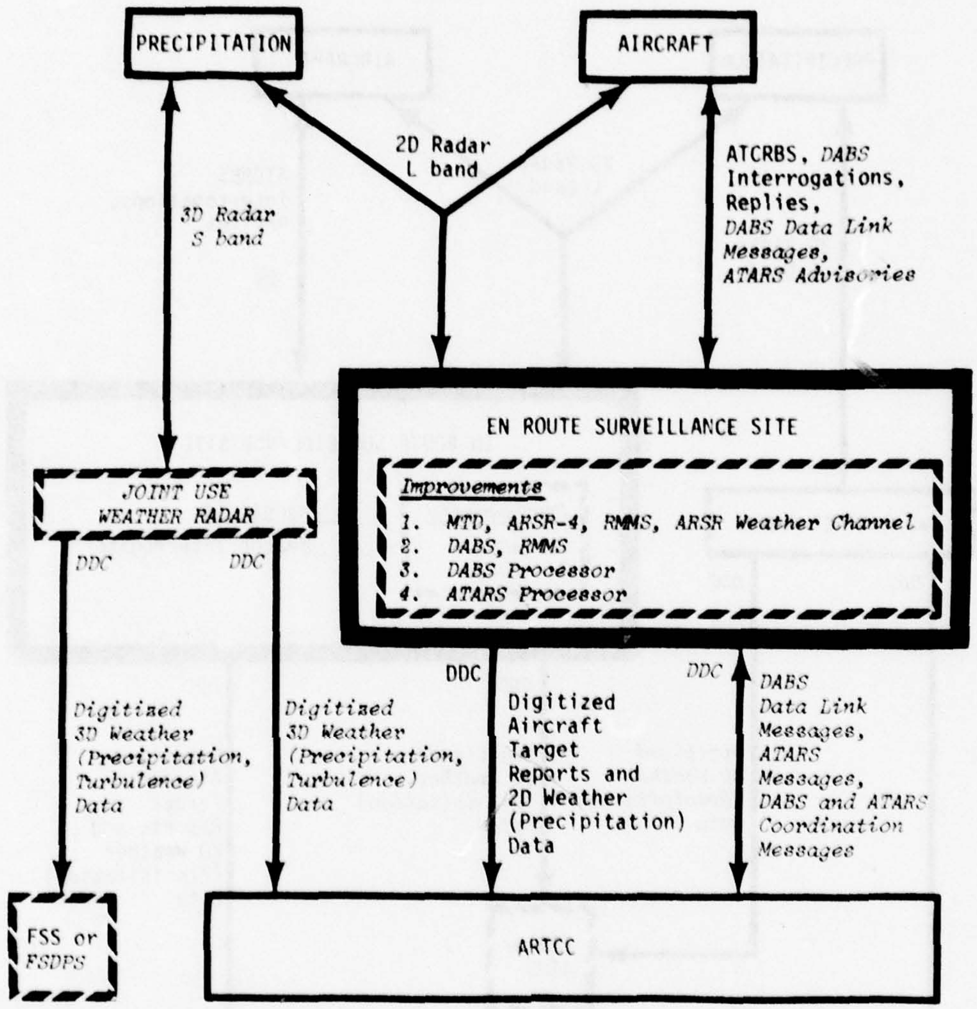


FIGURE 7-1
CURRENT EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 7-2
NEAR TERM EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM



NOTES

1. Both weather improvements (i.e., the Joint Use Weather Radar and the ARSR Weather Channel) are shown.

2. Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 7-3
FAR TERM EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM

In the Far Term, three additional changes in connectivity are likely to be made:

- The installation of DABS would mean that digital data link messages would be sent back and forth between various aircraft and the ARTCCs, and DABS coordination messages might be exchanged between adjacent DABS sites.

- The installation of the ATARS Processor would mean that ATARS advisories would be sent to the aircraft via the DABS data link, and ATARS coordination messages might be exchanged between adjacent DABS sites.

- A separate Joint Use Weather Radar network might replace the ARSRs as the source of weather data for the ARTCCs, and in addition, might automatically detect turbulence.

7.1.3 En Route Surveillance Site Information Flow

This section utilizes Figure 7-4 to describe in more detail the impact of the Near Term and Far Term improvements, briefly summarized in Section 7.1.1, on the external information flow and the internal functions performed at each en route surveillance site.

7.1.3.1 Near Term Improvements

The only Near Term improvement which would impact either the functions performed at an en route surveillance site or the external information flow is the utilization of the existing NWS Weather Radars to provide three-dimensional weather data to some ARTCCs, FSSs, and AFSSs.

FUNCTIONS

INPUTS

CURRENT

OUTPUTS

Current — Inputs

AIRCRAFT

- SEARCH RADAR RETURNS
- ATCBI REPLIES

PRECIPITATION

- SEARCH RADAR RETURNS

Current — Functions

1. SEARCH RADAR
   - PULSE TRANSMISSION
   - TARGET DETECTION AND THE REJECTION OF CLUTTER (MTI)
2. BEACON INTERROGATOR
   - ATCRBS INTERROGATIONS
   - REPLY DETECTION
3. SURVEILLANCE DATA PREPROCESSING
   - TARGET DATA QUANTIZATION AND THE CORRELATION OF SEARCH RADAR AND BEACON INTERROGATOR DATA (CD)
   - WEATHER (PRECIPITATION) DETECTION AND QUANTIZATION (WFMU)

Current — Outputs

AIRCRAFT

- SEARCH RADAR TRANSMISSIONS
- ATCBI INTERROGATIONS

PRECIPITATION

- SEARCH RADAR TRANSMISSIONS

ARTCC

- SEARCH RADAR
  - DIGITIZED AIRCRAFT TARGET REPORTS (RANGE, AZIMUTH)
  - DIGITIZED 2D WEATHER DATA (WFMU)
  - BROADBAND (VIDEO) AIRCRAFT AND 2D WEATHER RETURNS (RANGE, AZIMUTH)
- ATCRBS
  - DIGITIZED AIRCRAFT TARGET REPORTS
  - BROADBAND AIRCRAFT TARGET REPORTS

FSS

- SEARCH RADAR
  - BROADBAND 2D WEATHER DATA

NEAR TERM

Near Term — Inputs

AIRCRAFT

- SEARCH RADAR RETURNS
- ATCBI REPLIES

PRECIPITATION

- SEARCH RADAR RETURNS

Near Term — Functions

1. SEARCH RADAR
   - PULSE TRANSMISSION
   - TARGET DETECTION AND THE REJECTION OF CLUTTER (MTI)
2. BEACON INTERROGATOR
   - ATCRBS INTERROGATIONS
   - REPLY DETECTION
3. SURVEILLANCE DATA PREPROCESSING
   - TARGET DATA QUANTIZATION AND THE CORRELATION OF SEARCH RADAR AND BEACON INTERROGATOR DATA *(CD-2)*
   - WEATHER (PRECIPITATION) DETECTION AND QUANTIZATION *(CD-2)*

Near Term — Outputs

AIRCRAFT

- SEARCH RADAR TRANSMISSIONS
- ATCBI INTERROGATIONS

PRECIPITATION

- SEARCH RADAR TRANSMISSIONS

ARTCC

- SEARCH RADAR
  - DIGITIZED AIRCRAFT TARGET REPORTS (RANGE, AZIMUTH)
  - DIGITIZED 2D WEATHER DATA (CD-2)
- ATCRBS
  - DIGITIZED AIRCRAFT TARGET REPORTS (RANGE, AZIMUTH, IDENTIFICATION, ALTITUDE)

FSS or AFSS

- SEARCH RADAR
  - DIGITIZED WEATHER DATA

FAR TERM

Far Term — Inputs

AIRCRAFT

- SEARCH RADAR RETURNS
- ATCRBS, *DABS* REPLIES
- *DABS DATA LINK MESSAGES*

PRECIPITATION

- SEARCH RADAR RETURNS

ARTCC

- *DABS DATA LINK MESSAGES*
- *DABS, ATARS COORDINATION MESSAGES*

Far Term — Functions

1. SEARCH RADAR
   - PULSE TRANSMISSION
   - TARGET DETECTION AND THE REJECTION OF CLUTTER *(MTD)*
   - WEATHER DETECTION *(ASR WEATHER CHANNEL)*
2. BEACON INTERROGATOR
   - ATCRBS, *DABS* INTERROGATIONS
   - ATCRBS, *DABS* REPLY DETECTION
   - *GROUND TO AIR TO GROUND DIGITAL DATA LINK (DABS)*
3. SURVEILLANCE DATA PREPROCESSING
   - TARGET DATA QUANTIZATION AND THE CORRELATION OF SEARCH RADAR AND BEACON INTERROGATOR DATA *(DABS PROCESSOR)*
   - WEATHER (PRECIPITATION) DETECTION AND QUANTIZATION *(ASR WEATHER CHANNEL)*
4. *ATARS ADVISORIES (ATARS PROCESSOR)*

Far Term — Outputs

AIRCRAFT

- SEARCH RADAR TRANSMISSIONS
- ATCRBS, *DABS* INTERROGATIONS
- *DABS DATA LINK MESSAGES*
- *ATARS ADVISORIES*

PRECIPITATION

- SEARCH RADAR TRANSMISSIONS

ARTCC

- SEARCH RADAR
  - DIGITIZED TARGET REPORTS (RANGE, AZIMUTH)
  - DIGITIZED 2D WEATHER DATA *(ASR WEATHER CHANNEL)*
- *DABS*
  - *DIGITIZED ATCRBS, DABS AIRCRAFT TARGET REPORTS (RANGE, AZIMUTH, IDENTIFY AND ALTITUDE)*
  - *DABS DATA LINK MESSAGES*
  - *DABS, ATARS COORDINATION MESSAGES*
  - *ATARS MESSAGES*

FIGURE 7-4
EN ROUTE SURVEILLANCE SITE INFORMATION FLOW DIAGRAM

At the present time, the National Weather Service (NWS) operates a network of WSR-57 weather radars to detect and observe precipitation. This network of 56 weather radars covers most of the Conterminous U.S. east of the Rocky Mountains, and at scattered locations in the west. In the Rocky Mountain area and throughout much of the Western U.S., NWS obtains its weather radar information from the FAA's ARSRs. NWS is currently sending broadband 3D weather information to some FSSs that are located near a WSR-57, and in the Near Term, NWS is planning to send digitized 3D weather data to some ARTCCs, FSSs, and AFSSs.

7.1.3.2 Far Term Improvements

There are five possible Far Term improvements that would impact the functions performed by an en route surveillance site or the external information flow if they are implemented: MTD, the ARSR Weather Channel, the Joint Use Weather Radar, DABS, and ATARS.

1. Moving Target Detector (MTD)

The FAA is considering the replacement of existing MTI circuitry with an MTD (Reference 7-1) on all 126 ARSRs in order to improve the detection of aircraft in the presence of clutter. This, in turn, would improve the quality of the surveillance data sent to the associated ARTCCs.

In addition to rejecting clutter due to the terrain, which is also rejected by the MTI, the MTD would also reject clutter due to the weather. This improvement is important not only for tracking aircraft that are

unequipped with an ATCRBS transponder, but also for tracking aircraft with a transponder that are temporarily not replying to beacon interrogations, e.g., due to aircraft shielding while the aircraft are turning. It is estimated that the MTD would provide approximately a 20 dB improvement in the detection of aircraft in heavy clutter in comparison with an MTI.

The technique used by MTIs and MTDs to separate real targets from the background clutter is the doppler shift phenomenon, i.e., the fact that most aircraft have a range rate (radial velocity) with respect to the radar site. Thus, the radar returns are shifted in frequency, whereas fixed ground clutter has no doppler frequency shift. Due to the use of a wide dynamic range (60 dB) linear receiver by the MTD, as opposed to the use of limiting in the IF amplifier by the MTI, subclutter visibility would be substantially improved by the MTD. In addition, the use of an adaptive thresholding technique in conjunction with digital doppler filter processing by the MTD would permit the removal of other nonstationary forms of clutter, such as weather, that are not removed by an MTI. And, a dynamic clutter map in the MTD would permit the detection of aircraft at or near zero radial velocity.

2. ARSR Weather Channel

ARSRs are currently optimized for target detection and thus eliminate weather information through such means as the use of circular polarization and the selection of the appropriate sensitivity time control (STC) curve.

However, in order to provide improved weather information, the FAA is considering the use of a second ARSR L band receiver channel on some ARSRs to optimize the detection of precipitation (Reference 7-2). Since target information would not be required from this receiver, it could be optimized to receive weather information, e.g., by having linear polarization and selecting a different STC. The detected precipitation information would be quantized by the new Dual Common Digitizer (CD-2) and the resultant digital data sent to the associated ARTCC and FSS or FSDPS. In addition, a Moving Target Detector (MTD) may be used to process the detected video from the weather receiver. The MTD was initially developed to improve the detection of aircraft in heavy clutter, but one of its attributes is the ability to separate ground clutter from weather clutter, and thus, forward only weather data from the weather receiver.

3. Joint Use Weather Radar

A further improvement in weather detection beyond the existing NWS Weather Radar and the ARSR Weather Channel is tentatively anticipated by the FAA. The Joint Use Weather Radar (Reference 7-2) should provide 3D precipitation data plus information on turbulence.

NWS and AWS are planning to replace their present weather radars with new S band doppler radars in the 1980's, and since this new radar network could potentially be used by the FAA to provide improved weather information to the ARTCCs and FSDPSs, it is quite possible that the FAA will joint NWS and AWS in the development of a new weather radar network for the Conterminous U.S.

This new Joint Use Weather Radar would probably utilize a pencil beam antenna to obtain three-dimensional weather (precipitation) information, and digital doppler filter processing to automatically detect turbulence and forecast its movement 10 to 20 minutes into the future. The digital processing would break up the doppler frequency spectrum into very small increments. Thus, information could be obtained not only on precipitation intensity and spectrum characteristics but also on the variation of these parameters from scan to scan. It is believed that severe turbulence can be reliably detected by analyzing these parameters.

4. Discrete Address Beacon System (DABS)

DABS would further improve the beacon system beyond ATCRBS by allowing a beacon interrogator to discretely address aircraft equipped with a DABS transponder, and by reducing the number of beacon interrogations per scan.

The fundamental difference between DABS and ATCRBS is the manner of selecting which aircraft responds to an interrogation. In ATCRBS, the selection is spatial and all aircraft within coverage of the main beam of the beacon interrogator's directional antenna respond. In DABS, each aircraft is assigned a unique address and interrogated individually. Selection of which aircraft would respond to an interrogation would be accomplished by including the aircraft's address in the interrogation. Directional antennas would continue to be used by the DABS interrogators in order to minimize interference between DABS sites and to determine the aircraft's azimuth.

Since the implementation of DABS ground sites and the installation of DABS transponders on aircraft would occur

over a period of many years, the DABS equipment would be designed to be compatible with the existing ATCRBS equipment. Thus, DABS interrogators would be able to interrogate ATCRBS transponders, and DABS transponders would be able to respond to ATCRBS interrogators.

Due to the relatively early stage of DABS implementation planning at the present time, there are still many issues to be resolved. Therefore, for this description of the ATC system, the following assumptions have been made:

- All en route surveillance sites would have a DABS capability with a range of 200 nautical miles and a scan rate of 5 to 6 seconds. This is twice the ARSR scan rate due to the use of back to back DABS antennas which would be required for ATARS.

- All en route surveillance sites would have an ATARS capability, but the ATARS range would be less than 200 nautical miles.

- Terminal surveillance sites associated with an ARTS III TRACON would have a DABS capability with a range of 60 nautical miles and a scan rate of 4 to 5 seconds.

- Terminal DABS sites would have an ATARS capability.

- At some sites, DABS and ATARS Coordination Messages might be sent to the adjoining DABS sites through the ATC facility(s) that interface with the DABS sites. The DABS Coordination Messages would be used to coordinate coverage between adjacent sites, and the ATARS Coordination Message would be used to

coordinate advisories to aircraft involved in conflicts near an ATARS boundary.

Each DABS site would consist of a DABS Beacon Interrogator and a DABS Processor. The ATARS capability would be added by installing an ATARS Processor which would interface with the DABS Processor.

The DABS Beacon Interrogator would transmit ATCRBS and DABS interrogations to the aircraft and detect the replies by using monopulse receivers. The DABS Processor would process these replies and estimate the location of each aircraft based upon a single transponder reply for DABS and only four replies for ATCRBS. Thus, the number of beacon transponder interrogations would be reduced in comparison with the current beacon system.

In addition, the DABS Processor would also: control the beacon interrogation modes of each site; control the data link message flow to and from the ARTCC and the aircraft; and correlate the beacon replies and the search radar returns to generate target reports (range, azimuth, altitude, and identity) on each aircraft for each antenna scan, and forward this surveillance data to the ARTCC.

5. Automatic Traffic Advisory and Resolution Service (ATARS) Processor

As described in Chapters 2, 3, the FAA has installed or is planning to install, software (conflict alert, conflict resolution) at the ARTCCs and ARTS III TRACONs to prevent midair collisions involving aircraft that are: in radio contact with an air traffic controller, equipped with an altitude

reporting (Mode C) ATCRBS transponder, and within coverage of a beacon interrogator.

The software at the ATC facility processes the surveillance data and alerts the air traffic controller who, in turn, alerts the pilot.

As an evolutionary improvement to this service, the FAA may install an ATARS Processor (Reference 7-6) at each en route surveillance site and each terminal surveillance site associated with an ARTS III TRACON. This processor would interface with the DABS Processor and would automatically generate advisories to all aircraft equipped with a DABS transponder and an ATARS display (not just aircraft in contact with the ATC system) to prevent midair collisions. ATCRBS and DABS surveillance information would be used by the processor to determine potential conflicts between aircraft. If a potential conflict was detected, then the DABS data link would be used to issue the appropriate advisories to resolve the conflict.

ATARS is viewed as a service that would be provided at the last possible moment to prevent a midair collision and, thus, its warning times would be less than the warning times associated with the conflict alert and conflict resolution algorithms. Since the maneuvers of aircraft responding to ATARS advisories might disrupt the orderly flow of IFR traffic, the ATARS messages would also be sent to the ARTCC or ARTS III TRACON.

Besides preventing midair collisions, the FAA is also considering

the inclusion of two additional features in ATARS: preventing collisions with the terrain or obstacles, and preventing violations of restricted airspace such as Terminal Control Areas.

7.1.4 En Route Surveillance Improvements Tentative Implementation Schedule

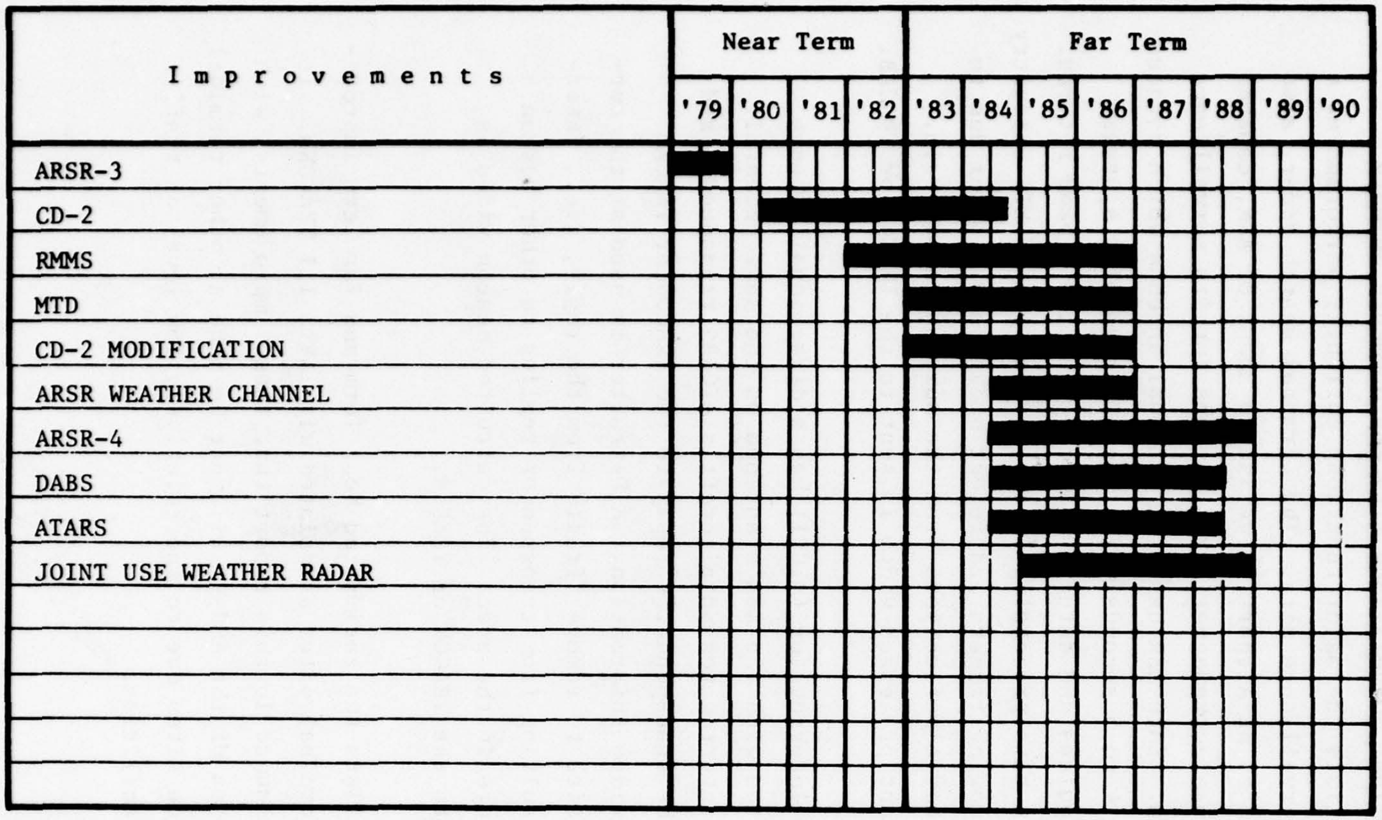
A tentative implementation schedule for the en route surveillance improvements is given in Figure 7-5. It should be emphasized that this schedule may change in the future depending upon the need and progress of the individual improvements.

Implementation information on some of these improvements (ARSR-3, and the CD-2) was obtained from preliminary budgetary information for Fiscal Years 1977 to 1980 (Reference 7-2, 7-5). Information on the remaining improvements is based upon discussions with the FAA personnel involved with these projects. At the present time, the only firm implementation plans for any of the anticipated en route surveillance improvements are those for the ARSR-3 and the Dual Common Digitizer (CD-2).

It has been assumed that the CD-2 will be modified to make it compatible with the MTD and the ARSR Weather Channel.

7.2 Terminal Surveillance Sites

This section briefly summarizes the functions currently performed at a typical terminal surveillance site and the anticipated Near Term and Far Term improvements. Due to the similarity between the current terminal and en route surveillance sites and the anticipated improvements at these sites, this section does not describe the terminal site improvements that are similar to the en route site improvements in the same level of detail as was given in Section 7.1.



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 7-5
EN ROUTE SURVEILLANCE IMPROVEMENTS TENTATIVE IMPLEMENTATION SCHEDULE

7.2.1 Terminal Surveillance Site Improvements Summary

Table 7-3 lists the major functions currently performed at a terminal surveillance site. The terminal search radar, also referred to as an Airport Surveillance Radar or ASR, depends solely upon electromagnetic reflections for its surveillance information. Each ASR has a directional antenna which rotates 360° every 4 to 5 seconds while the ASR transmits a stream of S band pulses and detects and processes the S band returns. Included in this processing is the utilization of MTI circuitry to detect moving targets and reject background clutter due to electromagnetic reflections from the surrounding terrain. The resultant processed video is sent to the TRACON or TRACAB.

The Beacon Interrogator (ATCBI) has a directional antenna which rotates with the ASR's antenna on the same pedestal. The ATCBI interrogates an aircraft's ATCRBS transponder and forwards the transponder's reply to the TRACON or TRACAB as beacon video information. A Defruiter is used at the surveillance site to remove "fruit" from the reply, i.e., interference resulting from transponder replies to other beacon interrogators in the area. The defruited beacon video is also sent to the TRACON or TRACAB.

Table 7-4 lists the anticipated Near Term and Far Term improvements at terminal sites associated with ARTS III TRACONs. It has been assumed in this report that these improvements, with the exception of the ASR-9, will not be made at other terminal surveillance sites due to the relatively low level of traffic at these facilities.

TABLE 7-3
CURRENT TERMINAL SURVEILLANCE SITE FUNCTIONS AND EQUIPMENT

FUNCTIONS	EQUIPMENT	
1. SEARCH RADAR		
• PULSE TRANSMISSION	S BAND TRANSMITTER	ASR
• TARGET DETECTION AND THE REJECTION OF CLUTTER	S BAND RECEIVER, MOVING TARGET INDICATOR (MTI)	ASR
2. BEACON INTERROGATOR		
• ATCRBS INTERROGATIONS	ATCRBS TRANSMITTER	ATCBI
• REPLY DETECTION	ATCRBS RECEIVER	ATCBI
3. DEFRUITER	DEFRUITER	ATCBI

TABLE 7-4
TERMINAL SURVEILLANCE SITE IMPROVEMENTS

FUNCTIONS	CURRENT SYSTEMS (1978)	NEAR TERM IMPROVEMENTS (1979-1982)	FAR TERM IMPROVEMENTS (POST-1982)
1. SEARCH RADAR			
• TARGET DETECTION AND THE REJECTION OF CLUTTER	MTI	NC	MTD
• WEATHER DETECTION	NA	NA	ASR WEATHER CHANNEL, JOINT USE WEATHER RADAR OR ASR PULSE DOPPLER WEATHER CHANNEL
• EQUIPMENT RELIABILITY AND MAINTAINABILITY	ASR-4,-5,-6,-7,-8	NC	ASR-9, RMMS
2. BEACON INTERROGATOR			
• INTERROGATION	ATCRBS TRANSMITTER	NC	DABS TRANSMITTER
• REPLY DETECTION	ATCRBS RECEIVER	NC	DABS RECEIVER
• GROUND TO AIR TO GROUND DIGITAL DATA LINK	NA	NA	DABS
• EQUIPMENT RELIABILITY AND MAINTAINABILITY	ATCBI-3,-4,-5	NC	DABS, RMMS
3. DEFRUITER	DEFRUITER	NC	DABS PROCESSOR
4. SURVEILLANCE DATA PREPROCESSING			
• TARGET DATA QUANTIZATION AND THE CORRELATION OF SEARCH RADAR AND BEACON INTERROGATOR DATA	NA	NA	DABS PROCESSOR
• WEATHER DETECTION AND QUANTIZATION	NA	NA	AUTOMATIC DETECTION OF TURBULENCE, WIND SHEAR
5. AUTOMATIC TRAFFIC ADVISORY AND RESOLUTION SERVICE (ATARS)	NA	NA	ATARS PROCESSOR

NC = NO CHANGE INCLUDED IN CURRENT PLANS
NA = NOT APPLICABLE

In the Near Term (1979-1982), there are no significant anticipated improvements.

In the Far Term (post 1982) eight significant improvements are tentatively being considered by the FAA:

- The replacement of MTI circuitry with MTDs.
- The installation of a separate weather channel in the ASRs to improve the quality of the precipitation data received.
- The installation of a separate Joint Use Weather Radar to provide 3D weather data. At some airports where this radar would not be installed by NWS, the FAA is studying the possibility of installing an ASR Pulse Doppler Weather Channel to provide a pulse doppler capability similar to the Joint Use Weather Radar.
- The utilization of this 3D weather data to automatically detect turbulence, and possibly wind shear, and to forecast its movement 10 to 20 minutes into the future.
- The replacement of vacuum tube ASR-4s, -5s, -6s with solid state ASR-9s.
- The installation of DABS with its capability to provide a ground to air to ground digital data link.
- The installation of ATARS Processors to automatically generate pilot advisories to prevent midair collisions.

- The installation of the Remote Maintenance Monitor System (RMMS) to monitor the performance of the equipment at the site and forward this information to the Tower Cab.

Beyond these anticipated Far Term improvements, the FAA is tentatively exploring two other improvements:

- The possible installation of some or all of the anticipated Far Term improvements described above at terminal surveillance sites associated with an ARTS II or AN/TPX-42 TRACON or TRACAB.

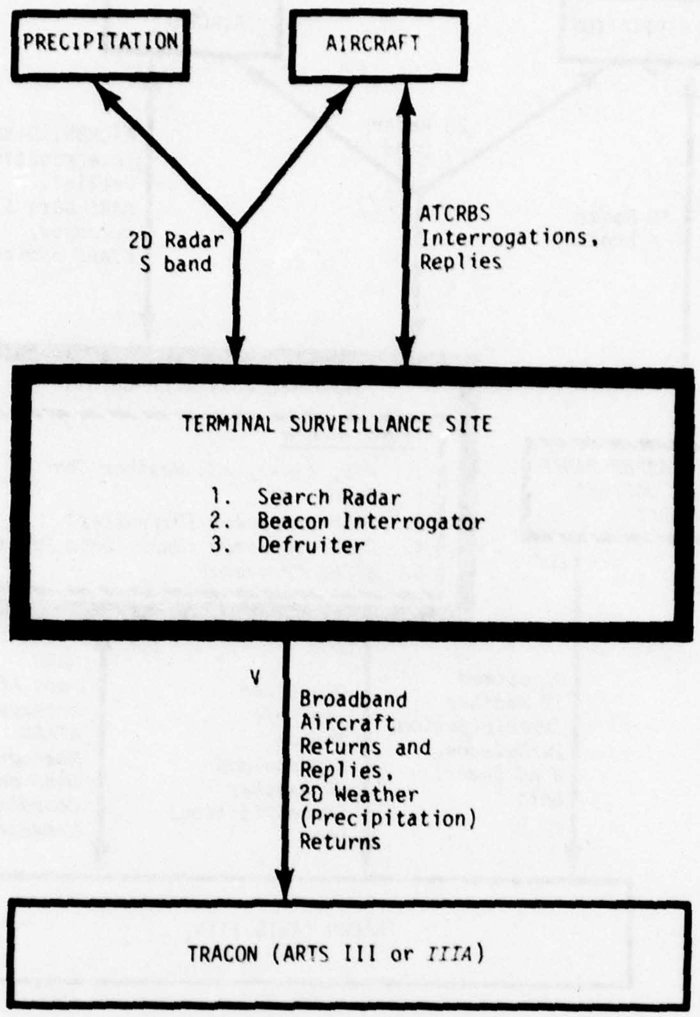
- The possible utilization of a Limited Surveillance Radar (LSR) at some airports that do not have an existing or planned terminal surveillance site located nearby and that would not qualify for an ASR. The LSRs would have a range of 20 nautical miles and less capability than an ASR.

7.2.2 Terminal Surveillance Site System Connectivity

Figures 7-6 and 7-7 illustrate the current connections between a terminal surveillance site and other ATC facilities and the changes in these connections due to the anticipated Far Term improvements.

In the Far Term, four significant changes in connectivity may be made:

- After the MTD and the ASR Weather Channel have been installed at a terminal surveillance site, narrowband (digital) surveillance data would be sent to the

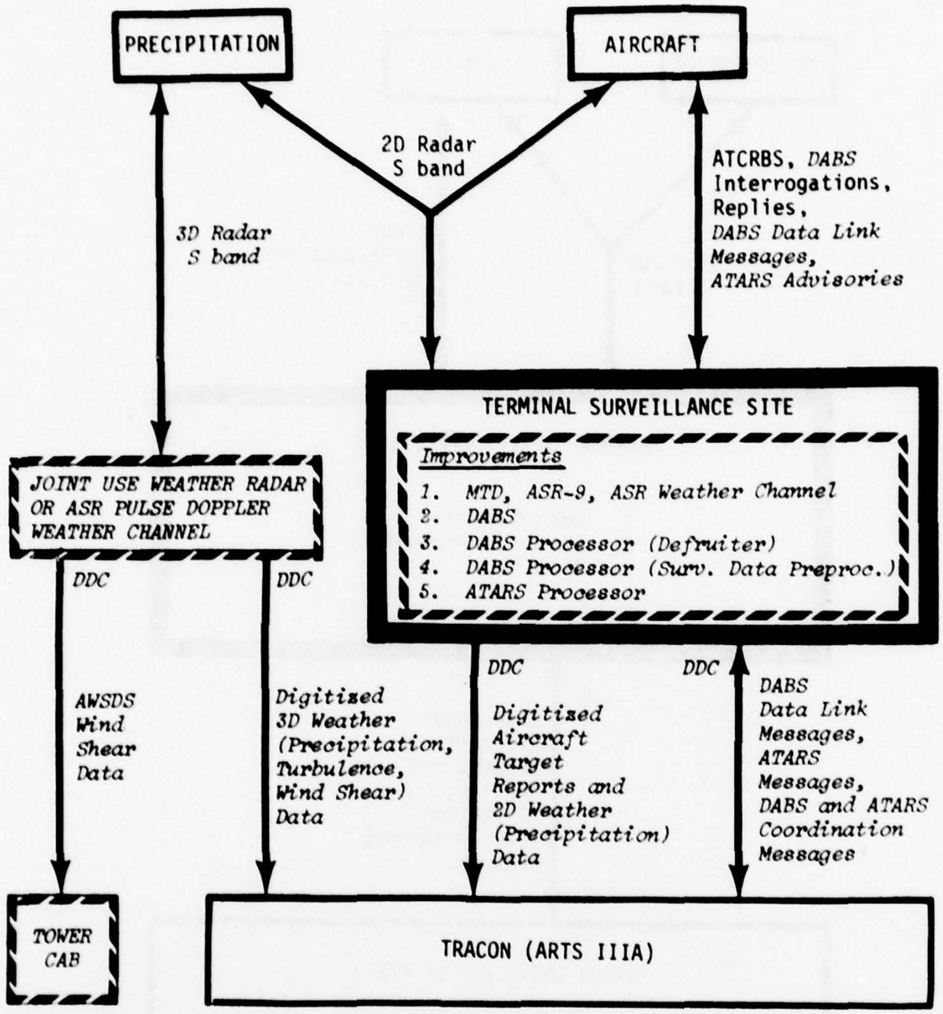


LEGEND

D = Directly Wired
DDC = Digital Data Channel
TTY = Teletypewriter Channel
V = Video Channel

VP = Voice Phone
VV = Voice, VHF or UHF Radio

FIGURE 7-6
CURRENT AND NEAR TERM TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM



NOTES

1. Both weather improvements (i.e., the ASR Weather Channel and the Joint Use Weather Radar or ASR Pulse Doppler Weather Channel) are shown.

2. Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 7-7
FAR TERM TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM

associated ARTS III TRACON. However, there is a possibility that broadband (video) surveillance data may still be sent to the TRACON as a backup.

- The installation of DABS would mean that digital data link messages would be sent back and forth between various aircraft and the ARTS III TRACON, and DABS coordination messages would be exchanged between adjoining DABS sites.

- The installation of the ATARS Processor would permit the issuance of ATARS advisories to the aircraft via the DABS data link.

- A separate Joint Use Weather Radar or an ASR Pulse Doppler Weather Channel might be used as the source of weather data for the ARTS III TRACON and, in addition, it may also provide wind shear data to the Tower Cab.

7.2.3 Terminal Surveillance Site Information Flow

This section utilizes Figure 7-8 to describe in more detail the impact of the Near Term and Far Term improvements, briefly summarized in Section 7.2.1, on the external information flow and the internal functions performed at each terminal surveillance site. Since a number of these improvements have already been described in Section 7.1.3 (e.g., MTD, ARSR Weather Channel, DABS, etc.), they will not be discussed again. Thus, only those improvements that are different from those implemented at en route surveillance sites will be described below.

There are five possible Far Term improvements that will impact the functions performed by a terminal surveillance site.

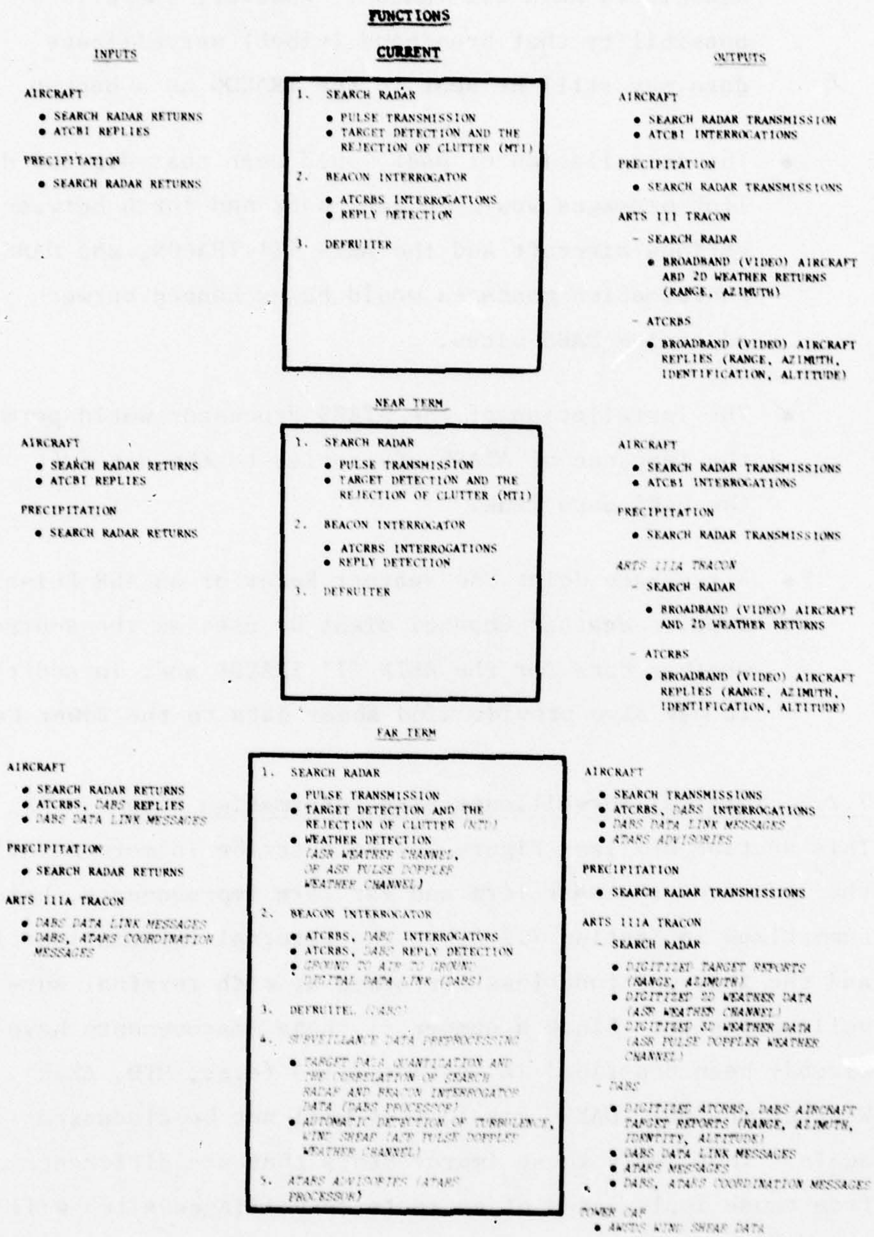


FIGURE 7-8
TERMINAL SURVEILLANCE SITE INFORMATION FLOW DIAGRAM (ASSOCIATED WITH AN ARTS III TRACON)

1. Moving Target Detector (MTD) - same an en route

2. ASR Weather Channel - this improvement would be similar to the ARSR Weather Channel, except that it would be an S band receiver instead of L band, and the information would be sent to an ARTS III TRACON instead of an ARTCC.

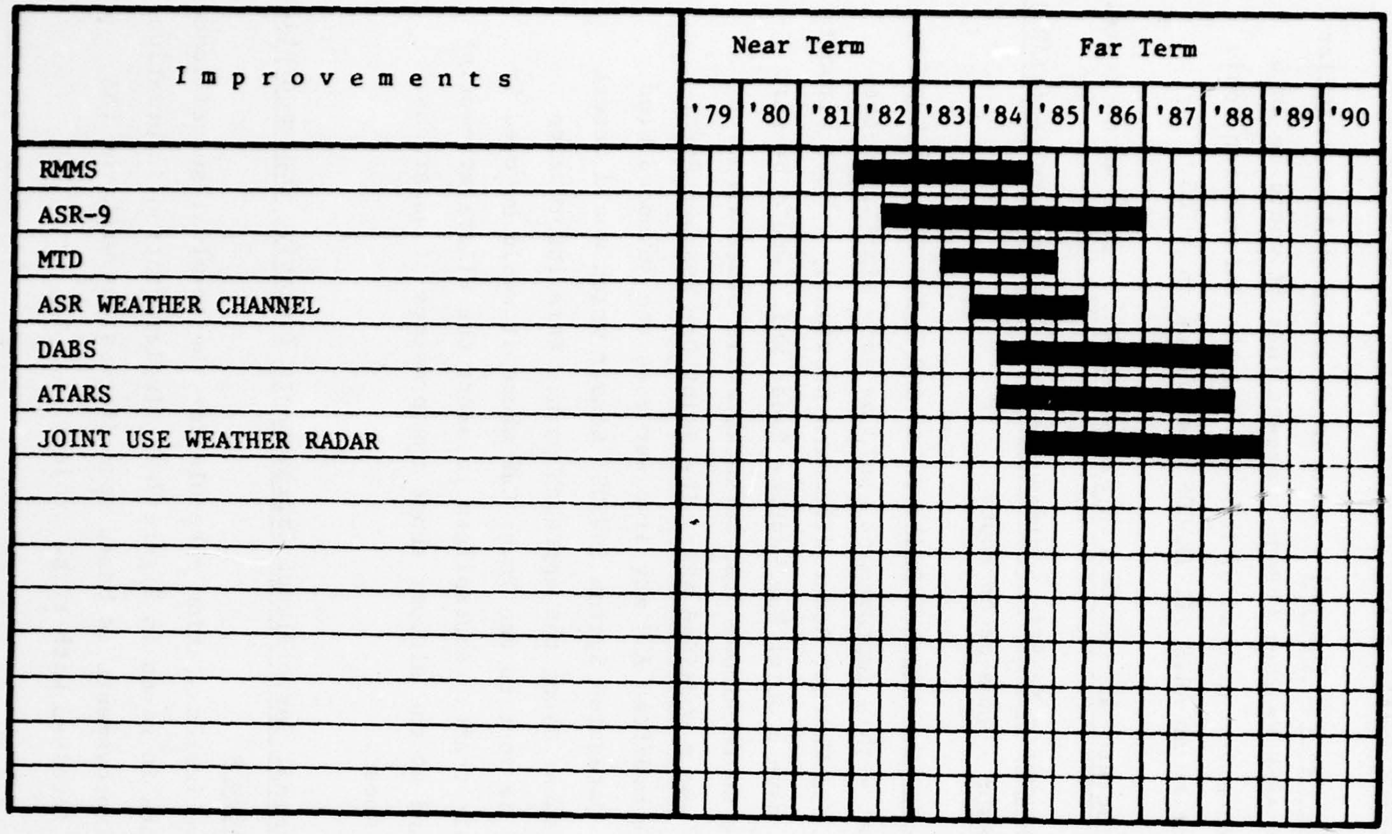
3. Discrete Address Beacon System (DABS) - same as en route.

4. Automatic Traffic Advisory and Resolution Service (ATARS) Processor - same as en route

5. Joint Use Weather Radar or an ASR Pulse Doppler Weather Channel - this improvement would be very similar to the Joint Use Weather Radar discussed previously. Some airports would have a Joint Use Weather Radar which would be part of the Conterminous U.S. network, while other airports would use a modified ASR. The Joint Use Weather Radar or the modified ASR may also serve as the Advanced Wind Shear Detection System (AWSDS) Sensor which would detect wind shear along the approach path. This information would be sent to the Tower Cab where it would be used by the air traffic controllers to alert the pilots attempting to land at the airport about the presence of hazardous wind shear.

7.2.4 Terminal Surveillance Improvements Tentative Implementation Schedule

A tentative implementation schedule for the terminal surveillance improvements is given in Figure 7-9. Implementation information on these improvements is based upon discussions with the FAA personnel involved with these projects.



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 7-9
TERMINAL SURVEILLANCE IMPROVEMENTS TENTATIVE IMPLEMENTATION SCHEDULE

It has been assumed that the Sensor Receiver and Processor (SRAP) will be located at the ARTS IIIA TRACON instead of the terminal surveillance site in the Near Term. SRAP will preprocess the surveillance data and thus offload the ARTS IIIA Processor. If the MTD and/or the ASR Weather Channel improvements are made in the Far Term, the SRAP would have to be modified at the ARTS IIIA TRACON to make the interface compatible.

7.3 Surveillance Facilities Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in keeping open the various options for implementing the output of the E&D program until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter, it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in the surveillance facility, and how they would interact with other facilities. This seciton identifies assumptions and areas of uncertainty by what are called "Open Items."

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&D and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases,

an Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness, they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features of functions of the surveillance facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for surveillance facilities. Instead, they might be contained within the program of another interfacing facility. The assumptions made with regard to the Open Items pertinent to surveillance facilities are:

Open Item 2: Evolution of DABS Capability

1. The DABS capability will be realized by a direct replacement of ATCRBS sensors with DABS sensors rather than by first upgrading ATCRBS sensors to include a monopulse detection and processing capability and then, at a later date, upgrading those sensors to the DABS configuration.

2. The DABS sensors installed for en route surveillance will include back-go-back antennas to increase the data rate. This assumption follows from a related assumption that ATARS will be implemented at the en route DABS sensors.

3. DABS sensors for improved surveillance and data link capability will be implemented at the earliest reasonable date. A corollary assumption is that the complete DABS sensors will be implemented sufficiently soon to preclude

the need for earlier installations of just the DABS data link capability at locations where the full DABS capability will eventually be deployed.

4. Initial DABS/ATARS implementation will be based on a single site collision avoidance capability. DABS surveillance information will be combined at the associated control facilities. Subsequent to the initial implementation, provisions will be made for exchanging data between selected DABS/ATARS sites to improve their collective collision avoidance capability. Several options are being explored to provide for the exchange of information. One of these options, the coordination through the associated ATC facility, was assumed in this document.

5. Initially, DABS implementation at terminals will be restricted to those sites having ARTS IIIA automation.

Open Item 3: Time Phasing of DABS vs Plans to Use DABS Data Link and Other DABS-Dependent Items

It was implicitly assumed that the FAA will develop a plan for using the DABS data link capability on a schedule that is consistent with the DABS implementation schedule and that the benefits, as perceived by user groups, would result in installation and use of associated avionics.

Open Item 4: Aircraft Separation Assurance

1. The assumption was made that all of the programs aimed at providing automated aids to the pilot and the controller for the avoidance of midair collisions will be successful and will be implemented. These programs include:

a. En Route Conflict Alert.

b. En Route Conflict Resolution advisory function.

c. Terminal Conflict Alert (ARTS III sites).

d. Terminal Conflict Resolution advisory function (ARTS IIIA sites).

e. ATARS (at all DABS sites).

f. BCAS -- "active only" for initial implementation but followed by more sophisticated systems later.

2. It was further assumed that the technical designs of each of the capabilities listed above will be realized within an overall design of an airborne separation assurance system which will assure proper interoperability among the various features and avoid presenting either the pilot or the controller with conflicting instructions or advisories.

Open Item 5: En Route Radars

1. It was assumed that no major changes would be made to improve either aircraft detection or weather detection in the en route airspace in the Near Term system (prior to 1983).

2. ARSRs (including the new ARSR-3s) will be modified to improve both their weather detection and aircraft detection capabilities in the Far Term. Aircraft detection will be improved through the addition of MTD. Weather detection will be improved through the addition of a separate ARSR weather channel.

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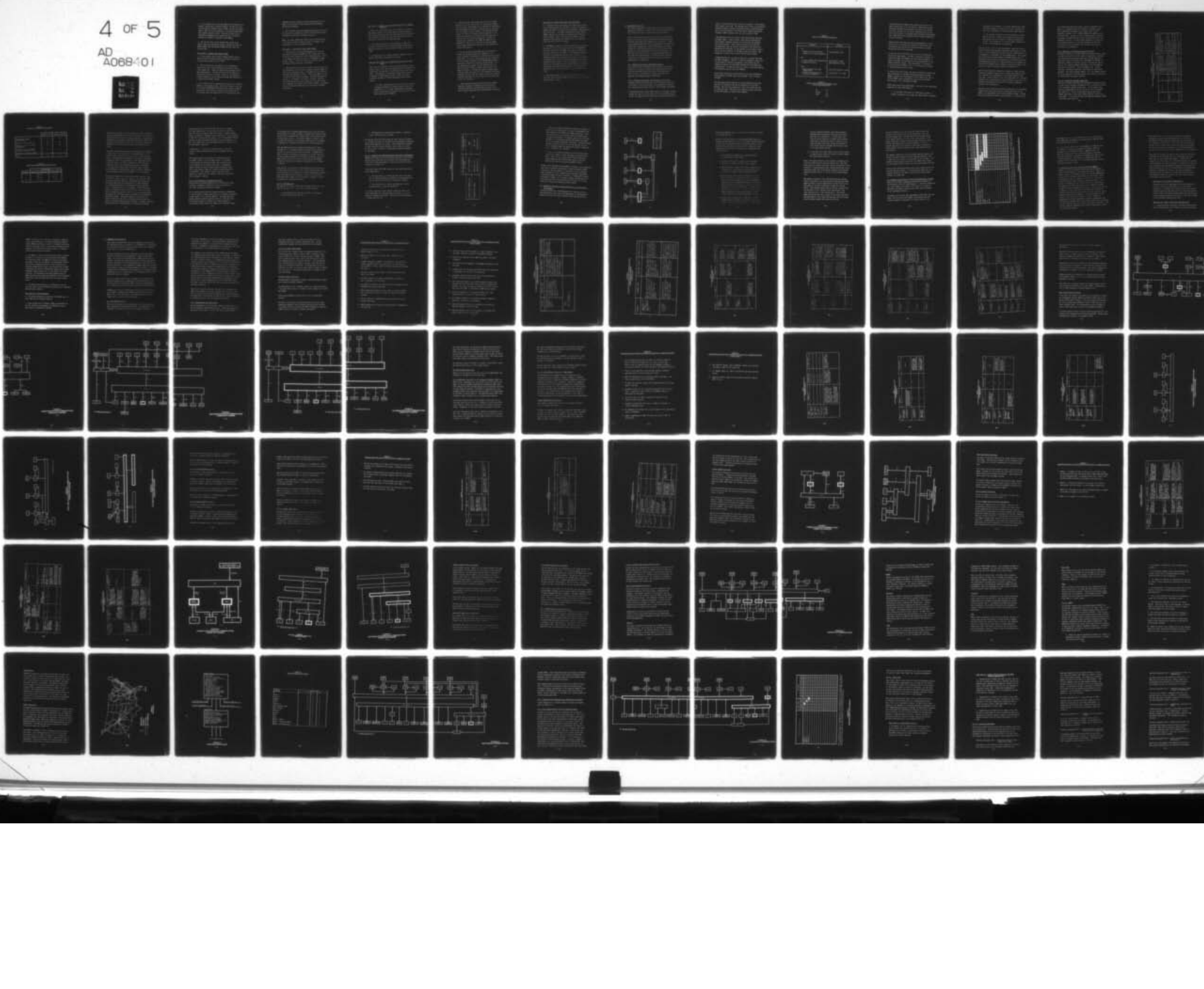


3. As a further step in the improvement in the detection of weather, particularly turbulent weather, the FAA will join with the National Weather Service (NWS), and the Air Weather Service (AWS) in the development of a new three-dimensional (3D) weather detection radar. This new 3D radar will be implemented throughout the conterminous U.S. to provide coverage of airspace of interest to the ARTCCs.

4. For the Far Term, it was assumed that the en route weather detection capability would be provided by both the ARSRs (ARSR-4 and the modified ARSRs) and the Joint Use Weather Radar.

Open Item 6: Terminal Area Radars (ASRs)

1. It was assumed that no major changes would be made to improve either aircraft detection or weather detection in the Near Term system (prior to 1983).

2. ASRs (including the new ASR-8s) will be modified to improve both their weather detection and aircraft detection capabilities. Those two modification programs will be made sequentially. Aircraft detection will be improved through the addition of an MTD. Later on, the weather detection capability will be improved through the addition of a separate ASR weather channel.

3. As a further step in improving the detection of turbulent weather in the terminal area, the FAA will depend on the use of the joint FAA/NWS/AWS 3D weather radar at those terminal areas where such coverage is available (see Open Item 5). A 3D weather detection capability will be provided at other

terminal locations through a further modification of the ASRs to include pencil beam antennas and pulse doppler processing techniques.

4. The 3D weather detection capability may also provide for the detection of turbulence and low level wind shear under all weather conditions, including clear air.

NOTE: The above assumptions implies that the FAA intends to continue to operate primary radars for terminal area surveillance for the foreseeable future.

Open Item 7: Surveillance Data Preprocessors

1. CD-2s will be procured and implemented for the preprocessing of ARSR and ATCRBS en route surveillance data. In the Far Term, these CD-2s will be modified twice: first to accommodate the MTD and later to accommodate an ARSR weather channel. Within a few years, the CD-2s will be replaced by DABS Processors (July 1984).

2. SRAP (sometimes referred to as SRAP I) will be procured and implemented for the preprocessing of ASR and ATCRBS terminal area surveillance data. The SRAPs will be located at the ARTS IIIA TRACON facilities. Those same SRAPs will go through two modification programs. The first modification will be to accommodate the addition of MTD to the ASRs. The second modification would come about six months later to accommodate the separate ASR weather channel. Six months later, the modified SRAPs would be replaced by the DABS Processors.

Open Item 17: Display of Digitized Surveillance at TRACONs and Towers

1. ASRs will be modified in the early 1980s to include an ASR weather channel for weather detection and processing and a Moving Target Detector for enhanced aircraft detection. This means that weather and aircraft surveillance information will be in the form of digitized data.

2. All-digital displays will be available at ARTS IIIA sites on a schedule that is compatible with displaying the digitized weather and aircraft data starting in the early 1980s.

3. No expansion of the digital display capability at the ARTS II and TPX-42 locations will be made.

Open Item 18: Detection of Turbulence and Low Level Wind Shear

This topic is in essence a recap of those portions of Open Items 5 and 6 on en route and terminal area surveillance concerned with the detection of turbulence and low level wind shear. The purpose in preparing a separate Open Item is to present a consolidated picture of just the weather detection situation to those interested in that special subject.

1. No major improvements will be made in the detection of hazardous weather in the Near Term ATC system configuration (i.e., no major improvements implemented prior to 1983 with the exception of the Low Level Wind Shear Alert System (LLWSAS)).

2. The first major improvement will start to be implemented in the early part of the Far Term system (1984). The first major improvement will be achieved by modifying both the ARSRs and the ASRs to include what is referred to as a separate weather channel. The separate weather channel is likely to include an MTD capability for the special processing of the returns from precipitation to indicate areas of heavy precipitation. In order to achieve this capability, all ARSRs and ASRs will be modified or replaced. In the case of both the ARSRs and the ASRs, the weather data will be two dimensional (range and azimuth).

3. The second major improvement will be realized by adding the 3D weather detection capability, i.e., range, azimuth, and altitude of turbulence and low level wind shear. For the en route system, the 3D capability will be realized through a joint FAA/NWS/AWS program to develop and implement a Joint Use Weather Radar. For the terminal area system, the 3D capability will be realized either through a further modification to the ASRs to provide a 3D capability and/or through inputs from the Joint Use radars for those terminal areas where coverage from the Joint Use radars satisfy the terminal control requirements for detecting low level wind shear as well as turbulence.

4. The 3D weather detection system for the terminal area will include the capability of detecting and analyzing turbulence and wind shear in clear air as well as under conditions where precipitation is present.

Open Item 20: Remote Maintenance and Monitoring

1. Integrated remote maintenance and monitoring functions will be incorporated into the RCAG, en route surveillance, VORTAC, and airport facilities for navigation, communications, and surveillance. The Remote Maintenance Monitor System (RMMS) capabilities consist of equipment monitoring and fault alarming, remote certification, automated record keeping, trend analysis and remote control of turbulent units and some facility functions.

2. The RMMS at airport facilities would utilize a special processor to be located in the associated Tower/TRACON. For other facilities, the RMMS will utilize a dedicated processor located at each ARTCC. All maintenance information will be transmitted from the cited facilities via existing communication links to the processor for storage, processing, and access by technicians using special common terminals located either local to the ARTCC or at remote locations. No assumptions were made regarding how the RMMS data would be provided and displayed to the responsible technicians since FAA plans have yet to be made in these areas.

3. The DABS and MLS systems to be installed in the far term will also incorporate RMMS functions that are compatible with the above concept.

8. NAVIGATION FACILITIES

This chapter describes the FAA ground facilities that provide navigation information to aircraft in en route and terminal area airspace as well as during approach and landing.

First, the functions currently performed by various navigation facilities are briefly discussed and the Near Term and Far Term improvements are summarized in Section 8.1. Then, a more detailed description of the anticipated functional and connectivity changes due to these improvements is given in Section 8.2, and a brief discussion of the tentative time phasing of these improvements is given in Section 8.3. In the final section, Section 8.4, the major assumptions that were made with regard either to interfaces with other ATC facilities or the time phasing of the various navigation improvements are summarized.

8.1 Navigation Facilities Improvements Summary

This section briefly describes the functions currently performed at en route and terminal area navigation facilities and the anticipated Near Term and Far Term improvements. This, in turn, is followed by a similar discussion of approach and landing navigation facilities.

8.1.1 En Route and Terminal Area Navigation Facilities

The FAA currently maintains three types of ground facilities to provide en route and terminal area navigation information for civilian and military aircraft: VOR, VOR-DME, and VORTAC.

A VHF Omnidirectional Range (VOR) ground site transmits azimuth information relative to the ground site via AM and FM signals at VHF. The phase difference between the AM and FM signals is

used by civilian and military aircraft to determine their bearing with respect to the VOR. The VOR may also be used to periodically transmit Automatic Terminal Information Service (ATIS) messages which are pre-recorded in the Tower Cab or Transcribed Weather Broadcast (TWEB) messages which are pre-recorded at FSSs.

A VOR-DME ground site co-locates a VOR with Distance Measuring Equipment (DME). A DME receives L band pulse interrogations from suitably equipped aircraft in the vicinity and responds with similar pulses. The distance between the aircraft and the DME ground site can then be calculated by the aircraft by measuring the difference in time between the aircraft's interrogation and the reception of the DME ground site's reply. DME equipment is used by both civilian and military aircraft.

A VORTAC ground site, as shown in Table 8-1, contains VOR, DME, and TACAN equipment. TACAN is a military navigation system that utilizes DME for distance information, and provides its own azimuth information via amplitutde modulation of the DME pulse transmissions. As shown in Table 8-2, most en route and terminal area navigation ground sites are VORTACs.

These ground facilities are distributed across the Conterminous United States to define three route systems: VOR, Jet Route, and RNAV.

The VOR Airway System consists of airways designated from 1200 feet AGL to 18,000 feet MSL and are referred to as "Victor" Airways. The Jet Route System has routes from 18,000 feet MSL to 45,000 feet MSL. Both the Victor Airways and the Jet Routes utilize VOR radials to define route segments.

TABLE 8-1
VORTAC FUNCTIONS AND EQUIPMENT

FUNCTIONS	EQUIPMENT
1. VOR	
• TRANSMIT AZIMUTH INFORMATION	VOR TRANSMITTER (VHF)
• TRANSMIT ATIS OR TWEB INFORMATION	
2. DME	
• DETECT AIRCRAFT DME INTERROGATIONS	DME RECEIVER (L BAND)
• TRANSMIT DME REPLIES	DME TRANSMITTER (L BAND)
3. TACAN	
• DETECT AIRCRAFT TACAN (DME) INTERROGATIONS	TACAN (DME) RECEIVER (L BAND)
• TRANSMIT TACAN (DME) REPLIES AND AZIMUTH INFORMATION	TACAN TRANSMITTER (L BAND)

TABLE 8-2
CURRENT FAA EN ROUTE AND TERMINAL AREA NAVIGATION GROUND SITES

VOR	189
VOR-DME	21
VORTAC	705
	915

The Area Navigation (RNAV) Route System has routes in the same altitude band as the Jet Routes. RNAV Routes utilize both VORs and DMEs for navigation information, but unlike the Victor Airways and Jet Routes, RNAV Routes do not restrict the aircraft to fly along routes defined by VOR radials. Thus, RNAV Routes give equipped aircraft greater flexibility in route selection.

Having briefly described the functions performed at current FAA en route and terminal area navigation facilities, the anticipated Near Term and Far Term improvements at these facilities will now be discussed.

In the Near Term (1979-1982) there is only one significant anticipated improvement. The FAA is planning to replace all vacuum tube VORs and VORTACs with solid state equipment in order to increase the reliability and maintainability of the VORTAC navigation system. This improvement is referred to as the Solid State VORTAC, and it is functionally equivalent to the existing ground facilities.

In the Far Term (post 1982), the FAA is tentatively considering the installation of the Remote Maintenance Monitor System (RMMS) to monitor the performance of each VORTAC site, and to forward VORTAC status information to the associated ARTCC (see Chapter 2 for a discussion of RMMS).

Beyond these anticipated improvements, the FAA is also tentatively exploring two other improvements:

1. The possible utilization of a DME digital uplink to transmit information from a DME site (DME identity, latitude,

longitude, and elevation) to aircraft equipped with RNAV, and thus eliminate the need for the crew to update and store this information in each aircraft's RNAV computer.

2. The possible utilization of time navigation in high density terminal airspace in conjunction with metering and spacing, and as a backup to a highly automated ATC system. Time navigation is a type of RNAV in which time is one of the parameters of the system.

Besides the FAA, various other governmental agencies maintain ground stations which transmit navigation information for their own use. This information can also be used by some aircraft as a supplement or replacement for the VORTAC system. For example, the Coast Guard maintains LORAN-C and OMEGA ground sites to provide maritime navigation information, and the Navy maintains VLF-NAVCOM ground sites for communications with its submarines. (Since the VLF-NAVCOM sites transmit synchronized signals, they can also be used to provide navigation information.)

The FAA is studying the possible utilization of these non-FAA navigation systems by helicopters in remote and offshore areas as a supplement or replacement for the VORTAC System in the near term. Another possible Near Term improvement for helicopter navigation as an alternative to these systems, is the use of an airborne radar system to "home in" on a beacon transmitter located at the destination.

The FAA is also studying the possible utilization of the NAVSTAR Global Positioning (GPS) satellite navigation system in the 1990's as a replacement for the present VORTAC System. NAVSTAR GPS may be deployed by DOD by the mid-1980's. It would consist

of 24 satellites and would provide accurate navigation information on a worldwide basis for a number of military users. This system might eventually also replace other civilian navigation systems, such as VORTAC, OMEGA, and LORAN-C, sometime after 1995. However, before the FAA can make a decision to replace the VORTAC System, further analysis will have to be performed to prove: the operational feasibility of this type of navigation system; its cost-effectiveness for both the FAA and the various potential civil aviation users; and its international acceptability.

8.1.2 Approach and Landing Navigation Facilities

As shown in Table 8-3, the FAA currently maintains several types of ground facilities for three types of approaches: precision and non-precision instrument approaches, and VFR approaches. Instrument approach procedures are established by the FAA for individual runways at specific airports, and they may have as many as four separate segments depending on how the approach procedure is structured. The four segments are: initial approach, intermediate approach, final approach, and missed approach. The final approach segment, i.e., the segment between the final approach fix and the runway, may either be a precision or non-precision instrument approach.

8.1.2.1 Precision Instrument Approaches

Precision instrument approaches are performed utilizing horizontal and vertical guidance information that is currently provided by an Instrument Landing System (ILS). At the present time, there are approximately 733 ILSs in the U.S. at 524 airports (see Table 8-4). A full ILS generates several electronic signals (Localizer, Glide Slope, Marker Beacons, and in a few cases, DME). It also has an associated approach lighting system to provide visual guidance.

TABLE 8-3
CURRENT APPROACH AND LANDING NAVIGATION FACILITIES
FUNCTIONS AND EQUIPMENT

			FUNCTIONS	EQUIPMENT
INSTRUMENT APPROACHES	PRECISION	ILS	• TRANSMIT HORIZONTAL GUIDANCE • TRANSMIT VERTICAL GUIDANCE • TRANSMIT MARKER LOCATIONS • DETECT AIRCRAFT DME INTERRO-GATIONS • TRANSMIT DME REPLIES • VISUAL HORIZONTAL GUIDANCE	LOCALIZER TRANSMITTER (VHF) GLIDE SLOPE TRANSMITTER (UHF) MARKER BEACONS (VHF) DME RECEIVER (L BAND) DME TRANSMITTER (L BAND) APPROACH LIGHTS
	NON-PRECISION	PARTIAL ILS	• TRANSMIT HORIZONTAL GUIDANCE • TRANSMIT MARKER LOCATIONS • VISUAL HORIZONTAL GUIDANCE	LOCALIZER TRANSMITTER (VHF) MARKER BEACONS (VHF) APPROACH LIGHTS
		VOR	• TRANSMIT HORIZONTAL GUIDANCE	VOR TRANSMITTER (VHF)
		NDB	• TRANSMIT HOMING SIGNAL	NDB TRANSMITTER (LF or MF)
VFR APPROACHES		VASI	• VISUAL VERTICAL GUIDANCE	VASI LIGHT BARS

TABLE 8-4
CURRENT AND PLANNED ILS DEPLOYMENT

	NUMBER OF ILSs	NUMBER OF AIRPORTS
NON-PRECISION APPROACH (NO GLIDE SLOPE)	86	70
CATEGORY I PRECISION APPROACH	553	362
CATEGORY II PRECISION APPROACH (OPERATIONAL)	42	40
CATEGORY II PRECISION APPROACH (ADDITIONAL DESIGNATED SITES)	45	45
CATEGORY IIIA PRECISION APPROACH	7	7
TOTAL	733	524

TABLE 8-5
PRECISION INSTRUMENT APPROACH CATEGORIES

	LANDING MINIMA	
CATEGORY	RUNWAY VISUAL RANGE (RVR)	DECISION HEIGHT
I	2400 Feet	200 Feet
II	1200 Feet	100 Feet
IIIA	700 Feet	0 Feet

The Localizer signal provides horizontal guidance information from a minimum distance of 18 nautical miles to the runway to align the aircraft with the runway centerline. This navigation information is provided by amptitude modulating a VHF carrier frequency with continuous 90 Hz and 150 Hz tones. When the amplitude of the two tones are equal, the aircraft is on course.

The Glide Slope signal provides vertical guidance by defining a glide path to the runway which is approximately at a 3^{o} elevation angle with respect to the runway at the touchdown point. This navigation information is provided by amplitude modulating a UHF carrier frequency in the same manner as the localizer signal. As shown in Table 8-5, there are three categories of precision instrument approach. A Category I ILS system, the system most widely used today, requires that landings be performed under higher visibility (RVR) and decision height criteria than Category II or IIIA systems.

The decision height is the altitude at which the pilot has to visually acquire either the runway or the approach lights during the precision approach. Depending upon the type of ILS system installed, two (Category I) or three (Category II, IIIA) Marker Beacons are installed along the approach path to inform the pilot of his progress. The Outer Marker Beacon is normally located at the point at which an aircraft will intercept the ILS glide path if it is at the appropriate altitude on the localizer course as defined by the instrument approach procedure. The Middle Marker is located at the point at which the pilot has to visually acquire either the runway or approach lights during a Category I landing, typically when the aircraft is approximately 1/2 nmi from the runway

threshold and at an altitude of 200 feet above the runway. The Inner Marker Beacon is located at the point at which the pilot has visually acquire either thr runway or approach lights during a Category II landing, when the aircraft is at an altitude of 100 feet or more above the runway. All of these Marker Beacons transmit an amplitude modulated signal of dots and dashes at 75 MHz. The signals vary with each Marker Beacon so that they can be individually identified.

In addition to, or in place of Marker Beacons, some ILSs utilize a DME to inform the pilot of his distance from the runway.

The approach lights aid the pilot in transitioning from instrument flight to visual flight either at the middle or inner marker by providing visual cues to keep the aircraft aligned with the runway centerline. The approach lights consists of rows of lights along the approach path from a point 1000 to 3000 feet from the runway threshold to the threshold. The lighting systems associated with a Category II system are more elaborate than those associated with a Category I system.

8.1.2.2 Non-Precision Instrument Approaches

Non-precision Instrument Approaches are performed utilizing horizontal navigation information that is provided by an ILS, VOR, or Non-directional Beacon (NDB).

All of these ground facilities provide navigation information to locate either a runway centerline for a straight-in approach, or the airport for a circling approach. Each approach has a minimum descent altitude associated with it, below which the pilot cannot descend to complete the landing unless he can visually acquire either the runway or the approach lights.

For Non-precision Instrument Approaches with an ILS, the glide slope signal is not used to define a descent path either because the ILS is not equipped with a glide slope or the aircraft lacks a glide slope receiver. A localizer signal is, however, used to align the aircraft with the runway centerline for a straight-in approach or to locate the airport for a circling approach.

VORs and NDBs may provide navigation information for either straight-in or circling approaches based upon their location in relation to the particular runway centerline. 2D RNAV may be used to provide a straight-in approach at an airport with only a VOR circling approach (due to the VOR's location), since the RNAV system on board the aircraft could utilize the VOR-DME navigation information to generate information for a straight-in approach.

NDBs generate a continuous LF or MF omnidirectional signal that is amplitude modulated with a three letter identification code except during voice transmission of pre-recorded messages (TWEBs) sent from Flight Service Stations. A pilot can utilize this omni-directional signal with the aircraft's compass to perform a non-precision instrument approach.

8.1.2.3 VFR Approaches

VFR approaches utilize a VFR traffic pattern and can only occur when the weather is at or above the following minimums.

1. VFR approaches in controlled airspace - visibility 3 miles, ceiling 1000 feet AGL.

2. VFR approaches in uncontrolled airspace - visibility 1 mile, aircraft clear of clouds.

The FAA has installed Visual Approach Slope Indicators (VASIs) at a number of airports to provide vertical guidance information during a VFR approach to a runway. The standard VASI consists of light bars that provide the pilot with a visual cue that he is on, above, or below a 3^{o} glide path during the approach to the runway.

8.1.2.4 Approach and Landing Navigation Facilities Improvements

Having briefly described the functions performed at the current approach and landing ground facilities, the anticipated Near Term and Far Term improvements at these facilities will now be discussed, see Table 8-6.

In the Near Term (1979-1982), there are two significant anticipated improvements.

1. The replacement of vacuum tube ILSs with solid state ILSs to improve equipment reliability and maintainability, and the installation of ILSs at additional airports.

2. The installation of 100 or more VASIs per year at airports until at least the mid-1990's.

In the Far Term (post-1982), besides additional VASIs, one other improvement is being developed by the FAA, i.e., the Microwave Landing System (MLS). MLS has two major advantages in comparison with ILS.

TABLE 8-6
NAVIGATION FACILITIES IMPROVEMENTS

	NEAR TERM IMPROVEMENTS (1979-1982)	FAR TERM IMPROVEMENTS (POST 1982)
EN ROUTE AND TERMINAL AREA	SOLID STATE VORTAC*	RMMS
APPROACH AND LANDING	ADDITIONAL ILSs* ADDITIONAL VASIs*	MLS, PDME ADDITIONAL VASIs

*APPROVED BY THE FAA FOR IMPLEMENTATION

1. Due to its higher transmission frequency (C-band), it would not be as susceptible to signal transmission problems caused by the terrain and nearby structures. Thus, its installation at some small airports should become economically feasible. In addition, due to the increased integrity of its guidance signals, MLS should encourage the use of automatic landings (autoland). Autoland provides the pilot with the ability to fly the aircraft all the way to touchdown under the appropriate weather conditions (i.e., visibility and ceiling).

2. Due to its scanning technique in both the horizontal and vertical planes, a wider coverage area would be provided. This, in turn, would permit the utilization of curved approaches and various glide paths at the more sophisticated sites by suitably equipped aircraft.

Besides these anticipated improvements, the FAA is also tentatively exploring the possible utilization of Head Up Displays (HUDs) on board air carrier aircraft to aid pilots in the transition from instrument to visual flight during instrument approaches. A HUD would enhance the pilot's ability to independently monitor an automatic landing, or to execute a manual landing with less likelihood that the aircraft would descend below the 3^{o} glide path after the decision height has been reached.

8.2 Navigation Facilities System Connectivity and Information Flow Changes

As shown in Figure 8-1, MLS (Reference 8-1) would be the only anticipated Near Term or Far Term improvement in FAA navigation ground facilities that affects either ATC system connectivity,

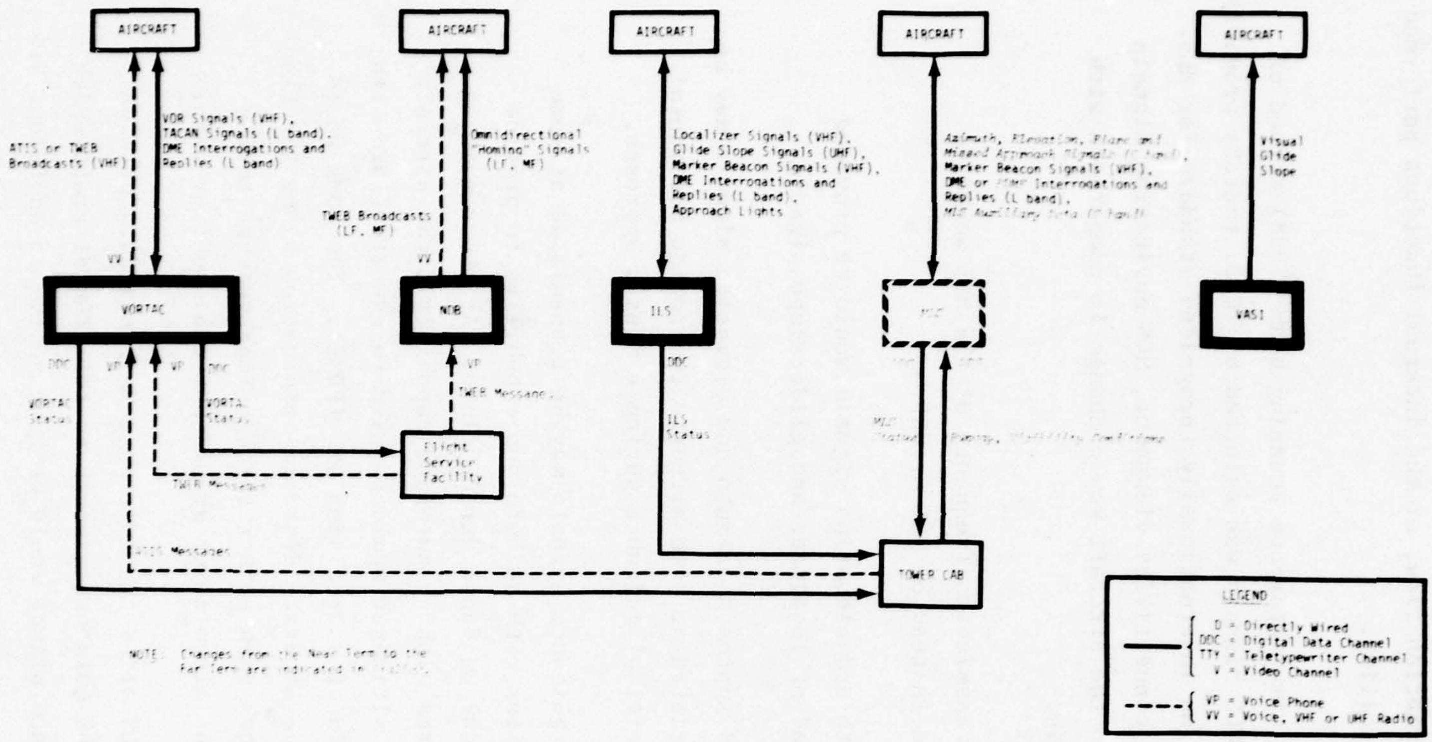


FIGURE 8-1
NAVIGATION FACILITIES CONNECTIVITY DIAGRAM

external information flow, or the internal functions performed at a ground facility.

Recently, the time reference scanning beam (TRSB) method of transmitting MLS signals was selected by ICAO, thereby providing the basis for an internationally recognized standard for MLS. From a system connectivity viewpoint, MLS navigation signals transmitted to the aircraft would change in comparison with ILS in six ways.

- The transmission frequency of the MLS would be C band instead of VHF or UHF.

- Azimuth and elevation signals would be provided instead of localizer and glide slope signals.

- Missed approach azimuth and elevation signals may be transmitted at some airports to provide horizontal and vertical guidance during a missed approach.

- Flare guidance signals may be transmitted at some MLS sites with an autoland capability to provide vertical guidance during flare. At the remaining airports with an autoland capability, the aircraft's radar altimeter would be used to execute flare with the aid of a Precision DME (PDME). The PDME would provide accurate distance information along the final approach path either through improvements to the current airborne or ground DME equipment or both.

- All MLS sites transmit basic digital data between the MLS guidance signals to tell the aircraft which guidance signal would be sent next. In addition, at

the more sophisticated MLS sites where automatic landings would be permitted, MLS auxiliary digital data would be transmitted. At these sites, the Tower Cab would send data on runway and visibility conditions to the MLS site where it would be combined with MLS siting data and MLS status data to form the MLS auxiliary message which would be sent to the approaching aircraft.

- At most MLS sites, DME signals would be used instead of marker beacon signals to locate the outer, middle and inner marker positions.

From a functional viewpoint, the navigation information provided by an MLS would be different from an ILS. Multiple glide paths and azimuth positions would be provided by an MLS instead of a single approach path, thereby permitting curved approaches within 40° of the runway centerline and descents along glide paths from 1° to 20° at the most sophisticated sites.

MLS azimuth, elevation, flare and missed approach signals would be provided by the time reference scanning beam (TRSB) method in which a narrow unmodulated fan beam would scan at high speed in alternate directions through the coverage sector. The scanning speed would be uniform, starting from one extremity of the coverage sector and moving to the other and then back to the starting point. The azimuth beams would scan from left to right of the runway centerline and then right to left, while the elevation and flare beams would scan down towards the ground and then up.

In every scanning cycle, two pulses (TO, FRO) would be received by the aircraft from each scanning beam. The time interval between the TO and FRO pulses would be proportional to the angular position of the aircraft with respect to the runway centerline (azimuth) and the ground (elevation, flare), and the high update rates for these signals, 13.5 Hz for azimuth and 40.5 Hz for elevation, would make it possible to design simple airborne processors that could minimize multipath effects.

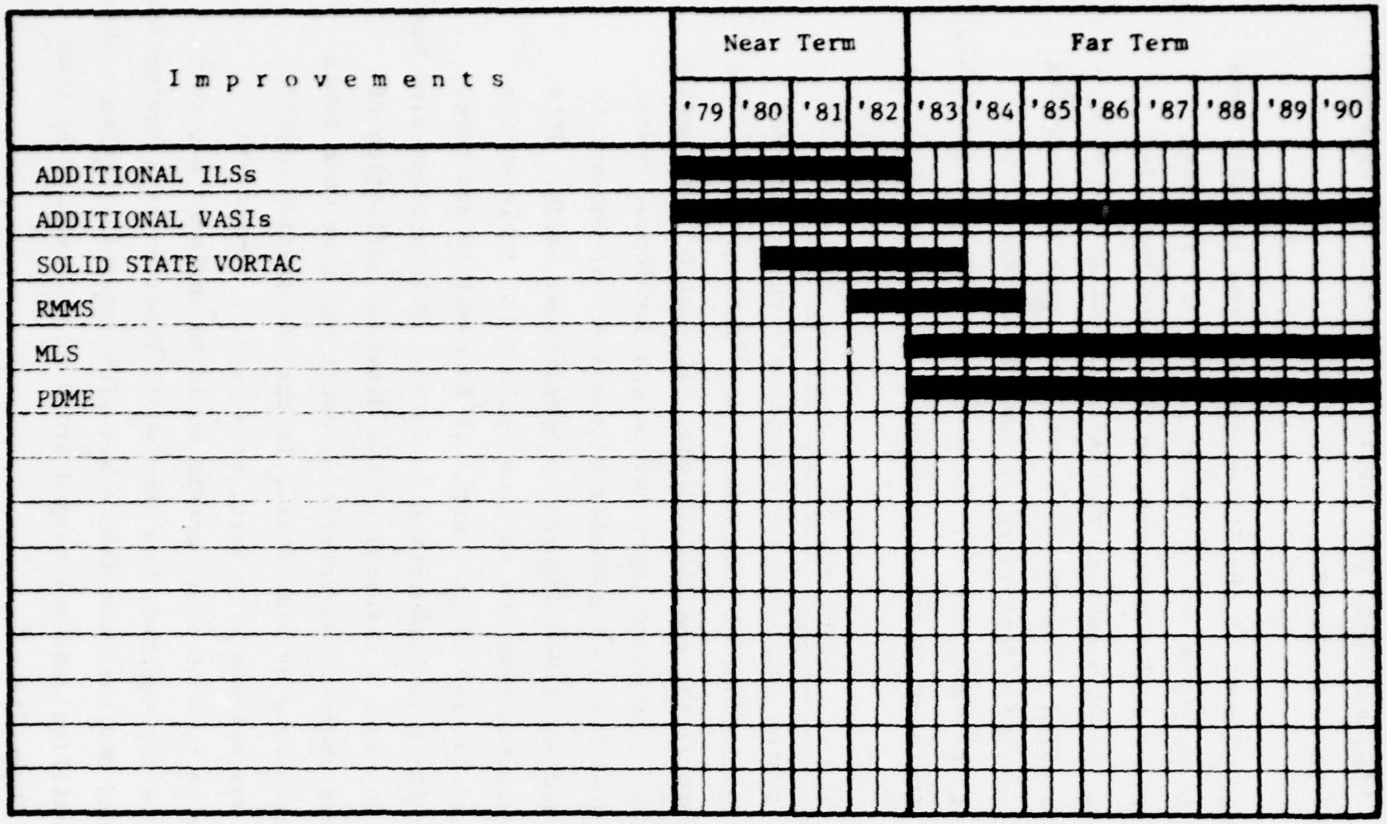
The azimuth, elevation, flare and missed approach signals, and the MLS auxiliary messages would be time-multiplexed so that a single aircraft receiver could process all of the data. Each guidance signal would be preceded by a preamble which would set the aircraft's MLS receiver for the function which followed.

Only the most sophisticated MLS sites would transmit all of the possible guidance signals. At the most basic MLS sites, only azimuth, elevation, and DME or marker beacon signals would probably be transmitted.

8.3 Navigation Improvements Tentative Implementation Schedule

Figure 8-2 provides a tentative implementation schedule for the navigation facilities improvements. It should be emphasized that this schedule may change in the future as a result of additional information concerning the need and the progress of the individual projects.

Information on the Near Term improvements (additional ILSs and VASIs, and the Solid State VORTAC) was obtained from preliminary budgetary information for Fiscal Years 1977 to



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 8-2
NAVIGATION FACILITIES IMPROVEMENTS TENTATIVE IMPLEMENTATION SCHEDULE

1980 (Reference 8-2), and information on the Far Term improvements (RMMS, MLS, and PDME) was obtained from the FAA personnel involved with these projects.

Due to the age of some of the ILS equipment, the FAA will have to continue to purchase new equipment to replace existing equipment until a decision is made to implement MLS. In addition, the FAA will have to maintain ILSs after the MLSs have been installed to accommodate different user needs during a transition period. Both types of landing system may be maintained at the same site for a relatively long time interval, perhaps as long as 15 years.

8.4 Navigation Facilities Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in keeping open the various options for implementing the output of the E&D program until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at a navigation facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "Open Items."

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, an Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the navigation facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for navigation facilities. Instead, they might be contained within the program of another interfacing facility. The assumptions made with regard to the Open Items pertinent to navigation facilities are:

Open Item 10: MLS/ILS/M&S Compatibility

Metering and Spacing algorithms will be refined/modified for use at those locations where it is operationally desirable to accommodate the concurrent use of the conventional straight-in approaches that are flown with guidance by the current Instrument Landing System (ILS) and the more flexible approach geometries that may be flown with guidance by the Microwave Landing System (MLS).

Open Item 20: Remote Maintenance and Monitoring

1. Integrated remote maintenance and monitoring functions will be incorporated into the RCAG, en route surveillance,

VORTAC, and airport facilities for navigation, communications, and surveillance. The Remote Maintenance Monitor System (RMMS) capabilities consist of equipment monitoring and fault alarming, remote certification, automated record keeping, trend analysis and remote control of redundant units and some facility functions.

2. The RMMS at airport facilities would utilize a special processor to be located in the associated tower/TRACON. For other facilities, the RMMS will utilize a dedicated processor located at each ARTCC. All maintenance information will be transmitted from the cited facilities via existing communication links to the processor for storage, processing, and access by technicians using special common terminals located either local to the ARTCC or at remote locations. No assumptions were made regarding how the RMMS data would be provided and displayed to the responsible technicians since FAA plans have yet to be made in these areas.

3. The DABS and MLS systems to be installed in the far term will also incorporate RMMS functions that are compatible with the above concept.

<u>Open Item 23: Future Navigation</u>

1. The primary navigation system will be VOR-DME until at least 1995 for the national airspace.

2. Other systems such as LORAN-C, OMEGA, and NAVSTAR GPS will be certified as supplements to VOR-DME in order to meet needs not satisfied by VOR-DME.

9. COMMUNICATIONS FACILITIES

This chapter discusses data and voice communications facilities and improvements that are planned to be implemented. The material is, therefore, divided into two sections; one on data communications, and one on voice communications.

The data communications section describes the facilities which provide for switching and transmission of data for FAA operations. All types of ground-ground data communications are described, including low speed point-to-point teletype, multipoint teletype, medium speed (300 through 9600 bps), data concentration and data switching. Data transmission channels which are accessed from telephone company switching equipment are omitted. Facsimile transmission and broadband radar transmission are included as data communications, since future plans call for meeting these requirements with digital techniques.

The voice communications section considers the facilities that provide air/ground voice communications between FAA ATC facilities and aircraft operating in CONUS, as well as ground/ground voice communications between FAA operated ATC and FSS facilities.

Communications directly impacting the provision of ATC services are included. Communications between the IFR aircraft and terminal and en route controllers, and between VFR aircraft and flight service stations are also included.

9.1 Data Communications

This section provides a brief discussion of the requirements for data communications among FAA facilities. The improvements and connectivity in each of four areas of automation (En Route

facilities, TRACON/Tower facilities, ATCSCC facilities and FSS facilities) are discussed. The planned NADIN configuration is described and compared to current FAA data communications facilities. Schedules for implementation are indicated, and areas for consideration for further study are identified.

For purposes of this discussion, data communications includes: (1) Communications between people, where the message is initiated on a keyboard device and is delivered on a page printer, cathode ray tube or printout device; (2) communication from a person to a machine, where the origination is at a keyboard and the delivery is in the form of data or commands for entry into a machine; (3) communication from a machine to a person where the origination is a stream of digital information and delivery is in the form of a printout; or (4) communication from one machine to another. In general, all data communications take the form of binary coded digital information transmitted electrically through wire or other paths; however, some analog transmissions are mentioned in this section (i.e., radar transmissions in video form) where there are plans in the Near Term or Far Term to replace this mode with a digital capability.

Specifically excluded from this discussion are connections between local machines or between a machine and its control console or closely associated user terminals where these equipments are physically located within the same facility and are considered an integral part of a data processing configuration.

9.1.1 Improvements and Connectivity

Various improvements in the FAA data communications service are in the planning or implementation stage. These improvements are described as they apply to each of the time periods (Current,

Near Term, and Far Term) for each of the major facility categories (En Route, Terminal, ATCSCC and FSS). Overall connectivity diagrams are also included for each category.

9.1.1.1 En Route Improvements

The en route data communications are comprised primarily of the following services; ARTCC to ARTCC, ARTCC to terminal, radar sites to ARTCC, and various teletype circuits to ARTCC. Some basic assumptions which were used in describing the en route data communications are listed in Table 9-1. The descriptions for the three periods of interest, Current, Near Term and Far Term, are contained in Table 9-2. An illustration of the configuration for each of the three time periods is shown in Figures 9-1, 9-2, and 9-3. Clarifying information is included in the next subsections.

Current En Route Facilities

The ARTCC-ARTCC transmission includes a 2400 bps primary channel, and a 2400 bps redundant channel.

The ARTCC-ARTS III has a 2400 bps computer-to-computer interface. A low speed FDEP circuit is retained to print strips in the tower and TRACON.

Nonautomated TRACONs are served only by the low speed FDEP circuits.

The TPX-42 is basically a hard-wired system, with very little computing capability, and no computer interface with the 9020. A low speed circuit is provided for FDEP equipment for printing flight strips in the TPX-42 terminals and towers.

TABLE 9-1
ASSUMPTIONS FOR EN ROUTE FACILITIES DATA COMMUNICATIONS

1. The NADIN information is per FAA-E-2661, specification for NADIN, January 4, 1977.

2. NADIN I and NADIN II are in Near Term. NADIN III is in Far Term.

3. A NADIN concentrator (NADIN II or NADIN III) can switch data between computers which are connected to the concentrator, such as ARTCC to ARTS. However, TTY data must be sent through the switch.

4. The data transfer between ARTCCs in Near Term and Far Term will be via NADIN.

5. The ARTS interface with NADIN includes ARTS III, ARTS II, and a replacement for the TPX-42.

6. The NADIN III interface with ARTS III will be through the TIPS equipment when TIPS is installed.

7. FDEP transmission channels in Near Term are rated at 150 bps, but the data rate is only 134.5 bps as limited by the FDEP printers.

8. The TTY channels for ARTCC-ARTCC were removed prior to the current time frame.

9. FDEP equipment will be used for strip printing in terminals in the Near Term.

TABLE 9-1
ASSUMPTIONS FOR EN ROUTE FACILITIES DATA COMMUNICATIONS (CONCLUDED)

10. TIPS will replace FDEP equipment in larger terminals in the Far Term. DTE will be used at the smaller terminals.

11. TIPS will be installed in all ARTS III, ARTS II and TPX-42 terminals.

12. The TPX-42 will be upgraded to programmable equipment in the Far Term.

13. An ARTCC will not interface with TPX-42 until Far Term, when a replacement for the TPX-42 is introduced.

14. Broadband radar and beacon data will not be retained for backup in the Near Term and Far Term.

15. Three 2400 bps channels, with three redundant channels, are provided for digitized radar data in Current and Near Term periods. The same configuration exists in Far Term, but the data rate after DABS is installed is 4800 bps per channel.

16. The CD-2 and ARSR-3 are introduced in Near Term. Data communications is the same for the two units.

17. Two 4800 bps channels are provided from DABS to ARTCC for data-link. One channel is redundant.

18. Digitized weather data will be available to the 9020 via separate channels in the Near Term.

19. Digitized weather data will be available to the 9020 from weather radar sites in the Far Term.

TABLE 9-2
EN ROUTE FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
1. ARTCC-ARTCC Flight Plan and Radar Handoff Data	Dedicated circuit from en route computer to the en route computer in each adjacent ARTCC (2400 bps) as primary channel. A redundant line is provided (full duplex).	NADIN II - Data Transfer from en route computer to NADIN concentrator (up to 40 kbps) to NADIN switch (4800 bps) to another NADIN concentrator (4800 bps), then to other en route computer (up to 40 kbps), vice versa (full duplex).	NADIN III - Data transfer same as for NADIN in Near Term.
NOTES NC = No Change NA = Not Applicable			

TABLE 9-2
EN ROUTE FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
2. ARTCC-ARTS III TRACONS			
a. Flight Plan Radar Handoff Data	Dedicated circuit from each ARTS III computer to the en route computer in the local ARTCC (2400 bps) as primary channel - no redundant lines (full duplex).	NADIN II - Data transfer from en route computer to NADIN concentrator (up to 40 kbps) then to ARTS III computer (2400 bps) and vice versa (full duplex).	NADIN III and ARTS III - Data transfer same as for NADIN II in Near-Term, except interface with ARTS-III is via TIPS.
b. Flight Strip/Tabular Data	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in ARTS III TRACON and tower to print flight strips (half duplex).	Dedicated FDEP channel (150 bps) from en route computer to FDEP equipment in TRACON and tower, to print flight strips (half duplex).	NADIN III and TIPS - Data transfer from en route computer to NADIN concentrator (up to 40 kbps), then to TIPS computer and printers (2400 bps) and vice versa (full duplex).

TABLE 9-2
EN ROUTE FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
3. ARTCC-ARTS II TRACONS a. Flight Plan and Handoff Data	NA	NADIN II - Data transfer from en route computer to NADIN concentrator (up to 40 kbps), then to ARTS II computer (2400 bps), and vice versa (full duplex).	NADIN III and TIPS (ARTS II) Data transfer same as for NADIN II in Near Term except interface with ARTS II via TIPS.
b. Flight Strip/ Tabular Data	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in non-automated TRACON and tower to print flight strips (half duplex).	Dedicated FDEP channel (150 bps) from en route computer to FDEP equipment in TRACON and tower, to print flight strips (half duplex).	NADIN III and TIPS - Data transfer from en route computer to NADIN concentrator (up to 40 kbps), then to TIPS computer and printers (2400 bps), and vice versa (full duplex).
4. ARTCC-TPX-42 TRACONS a. Flight Plan and Handoff Data	NA	NA	NADIN III and TIPS Data transfer from en route computer to NADIN concentrator (up to 40 kbps), then to replacement for TPX-42 (2400 bps) via TIPS, and vice versa (full duplex).
b. Flight Strip/ Tabular Data	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in TPX-42 terminal and tower to print flight strips (half duplex).	Dedicated FDEP channel (150 bps) from en route computer to FDEP equipment in TRACON and tower, to print flight strips (half duplex).	NADIN III and TIPS Data transfer from en route computer to NADIN concentrator (up to 40 kbps), then to TIPS computer and printers (2400 bps) and vice versa (full duplex).

TABLE 9-2
EN ROUTE FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
5. ARTCC-VFR TOWER	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in a VFR tower cab to print flight strips (half duplex).	Dedicated FDEP channel (150 bps) from en route computer to FDEP equipment in TRACON and tower, to print flight strips (full duplex).	NADIN III and DTE - Data transfer from en route computer to NADIN concentrator (up to 40 kbps), to NADIN switch (4800 bps) to NADIN concentrator (4800 bps) to DTE at VFR tower (2400 bps) and vice versa (half duplex).
6. ARTCC-CS/T	Area B Network - Transfer of flight informaton from CS/T to ABDIS (75 bps), to ARTCC (75 bps) and vice versa (half duplex).	NADIN II - Transfer of flight information from CS/T to NADIN concentrator (150 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), to ARTCC terminal (2400 bps) and vice versa (half duplex).	NADIN III - Transfer of flight information from CS/T to NADIN concentrators (2400 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps) to ARTCC terminal (2400 bps) and vice versa (half duplex).
7. SURVEILLANCE SITES-ARTCC a. Digitized Search and Beacon Data	Three dedicated channels from each CD at a surveillance site to the local en route computer (2400 bps each). Three redundant channels are provided for backup, but a common DTC and common modems at the surveillance site serve both the primary and the backup channels (simplex).	Three dedicated channels from each CD-2 (or ARSR-3) at a surveillance site to the local en route computer (2400 bps each). Three redundant channels are provided for backup. Separate modems at each end, and separate DTCs at the surveillance site are provided for the primary and the backup channels (simplex).	Three dedicated channels from each DABS processor at a radar site to the local en route computer (4800 bps each). Three redundant channels are provided for backup. Separate modems at each end are provided for the primary and the backup channels (simplex).
b. Broadband Search and Beacon Data	FAA-owned Radar Microwave Link (RML) from each surveillance site to the local ARTCC, as backup for the digitized data (simplex).	Deleted	NC

TABLE 9-2
EN ROUTE FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
8. DATA LINK-ARTCC	NA	NA	One dedicated channel from each DABS processor to a front-end processor at the local en route computer (4800 bps) plus an identical channel for backup (full duplex).
9. JOINT USE WEATHER RADAR--ARTCC	NA	NA	Data transfer via one dedicated channel from ARTCC to nearest Joint Use Weather Radar site (2400 bps) (full duplex).
10. ARTCC-FLIGHT SERVICE a. Non-Automated	Area B TTY Network - Transfer of IFR flight plan data from flight service stations and combined station/towers to ABDIS switch (75 bps) then to ARTCC for entry into the en route computer (75 bps) (half duplex).	NADIN I - Data transfer from FSS station to NADIN concentrator (75 bps or 1200 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), then to en route computer (up to 40 kbps) and vice versa (half duplex).	NADIN III - Data transfer from FSS to NADIN concentrator (75 or 2400 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), then to en route computer (up to 40 kbps) and vice versa (half duplex).
b. Automated	NA	NADIN I - Data transfer from FSDPS to NADIN concentrator (2400 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), to en route computer (up to 40 kbps) and vice versa, (half duplex).	NADIN III - Same as NADIN I in Near Term.
11. ARTCC-BASOPS, and AIRLINE OFFICES	Utility B TTY Network - Transfer of IFR flight plans from BASOPS, Airline Offices, to en route computer (75 bps) (half duplex).	NADIN I - Data transfer from TTY or DTE station to NADIN concentrator (75 bps or 1200 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), then to en route computer (up to 40 kbps), and vice versa (half duplex).	NADIN III - Data transfer same as for NADIN I in Near Term.

TABLE 9-2
EN ROUTE FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONCLUDED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
12. ARTCC-CANADIAN CENTERS	APTN Network - Transfer of IFR flight plans from Canadian centers to APTN (75 bps), then to ARTCC (75 bps), and vice versa (half duplex).	NADIN I - Data transfer from Canadian center to Canadian APTN switch, to NADIN switch (1200 bps), to NADIN concentrator (4800 bps), then to en route computer (up to 40 kbps), and vice versa (half duplex).	NADIN III - Data transfer same as for NADIN I in Near-Term with possible upgrade to 2400 bps.
13. CENTER-CENTER	Center B TTY Network and Switch - Interchange of flight plan data between centers on same loop (Eastern or Western) and between centers on separate loops, via switching capability at NATCOM (75 bps) (half duplex).	Deleted	NC
14. NWS-ARTCC	One dedicated telephone line to carry weather chart data from NMC to facsimile printer in each ARTCC.	NC	Dedicated circuit from WSFO to ARTCC for AFOS data (2400 bps). An additional circuit will be provided for back up.
15. ARTCC-WMSC	Service A - Weather data and Request/Reply service from WMSC (75 bps) (half duplex).	NADIN II - Data transfer from DTE to NADIN concentrator (2400 bps), to NADIN switch (4800 bps), to WMSC (4800 bps) and vice versa.	NC
16. ARTCC-CFJC	Movement data transmitted by ARTCC to one of five ARTCCs (2400 bps) then dedicated line to CFJC (2400 bps).	NADIN II Data transfer from ARTCC to NADIN concentrator (up to 40 kbps), to NADIN switch (4800 bps), then to CFJC (4800 bps).	NC
17. ATCSCC-ARTCC	Directives transmitted by ATCSCC to ARTCC via Center B (75 bps multipoint) service. Also faxsimile service via dedicated lines.	NADIN II-Directives transmitted by ATCSCC to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), then to ARTCC (up to 40 kbps). FAX service maintained.	NC

Low speed circuits are also provided for FDEP equipment in VFR towers.

Digitized search and beacon data are transmitted from surveillance sites to an ARTCC via three 2400 bps channels. Three identical channels are provided for redundancy. Also, broadband service is retained for a second level of backup.

Teletypewriter service is provided on three different networks; Area B, Utility B and Center B. The first two networks are connected directly to the 9020 computer. The Center B network has a terminal in the ARTCC, but is not connected to the 9020.

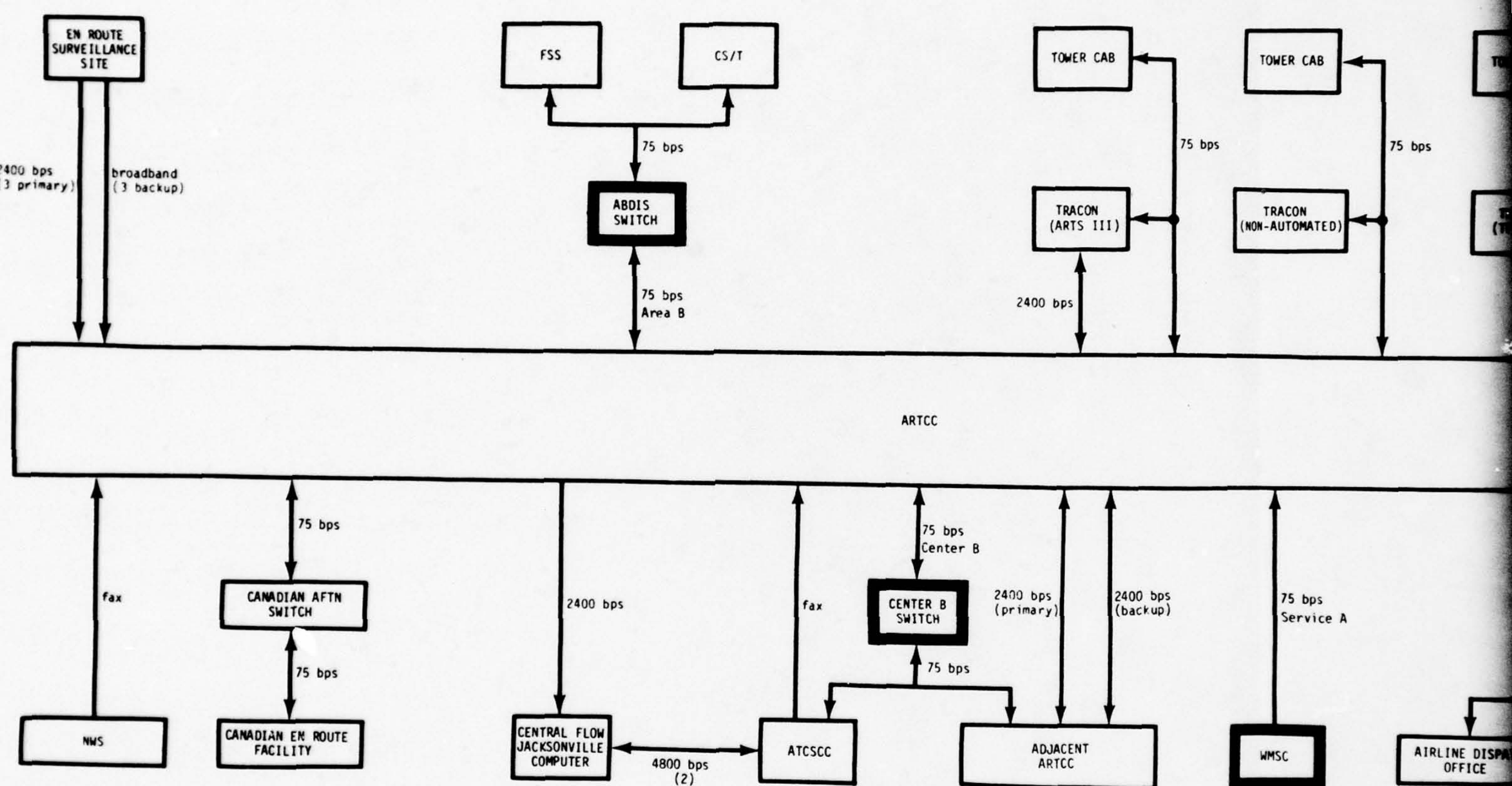
Movement reports are transmitted to the Central Flow Jacksonville Computer (CFJC) via one of five ARTCCs that relay these messages to the CFJC.

Each ARTCC has a facsimile printer for copying weather charts from the National Meteorological Center (NMC). Transmission is over a single dedicated voiceband telephone line.

<u>Near Term En Route Facilities</u>

In the Near Term, NADIN I and NADIN II are introduced to replace all transmission between ARTCCs, and between ARTCC and all terminals, except FDEP terminals. The user equipment (TTY station, etc.) are in many cases upgraded to 1200 or 2400 bps data terminal equipment (DTE). The transmission system is changed in order to more efficiently utilize the transmission channels.

All three teletype circuits (Area B, Utility B and Center B), are replaced with transmission and switching by NADIN. In many cases, teletypewriter terminals are upgraded to DTEs.



EN ROUTE SURVEILLANCE SITE
2400 bps (3 primary)
broadband (3 backup)
FSS
CS/T
75 bps
ABDIS SWITCH
75 bps Area B
TOWER CAB
75 bps
TRACON (ARTS III)
2400 bps
TOWER CAB
75 bps
TRACON (NON-AUTOMATED)
ARTCC
fax
NWS
75 bps
CANADIAN AFTN SWITCH
75 bps
CANADIAN EN ROUTE FACILITY
2400 bps
CENTRAL FLOW JACKSONVILLE COMPUTER
4800 bps (2)
fax
ATCSCC
75 bps Center B
CENTER B SWITCH
75 bps
2400 bps (primary)
2400 bps (backup)
ADJACENT ARTCC
75 bps Service A
WMSC

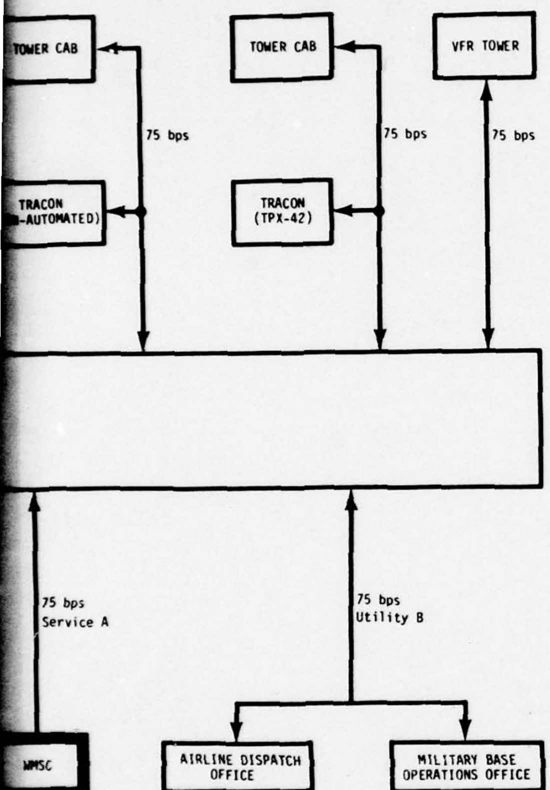
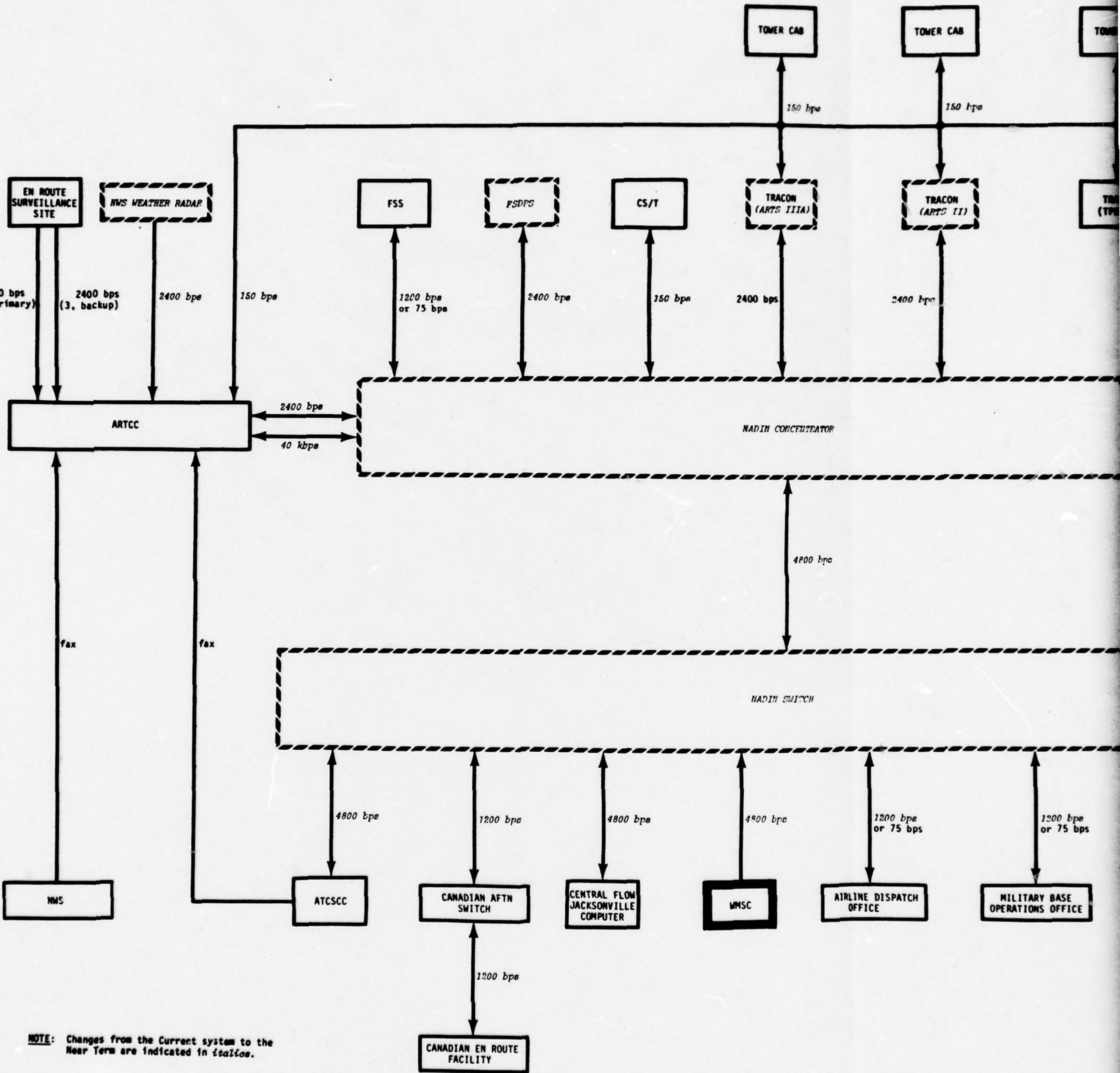


FIGURE 9-1
CURRENT EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

2



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

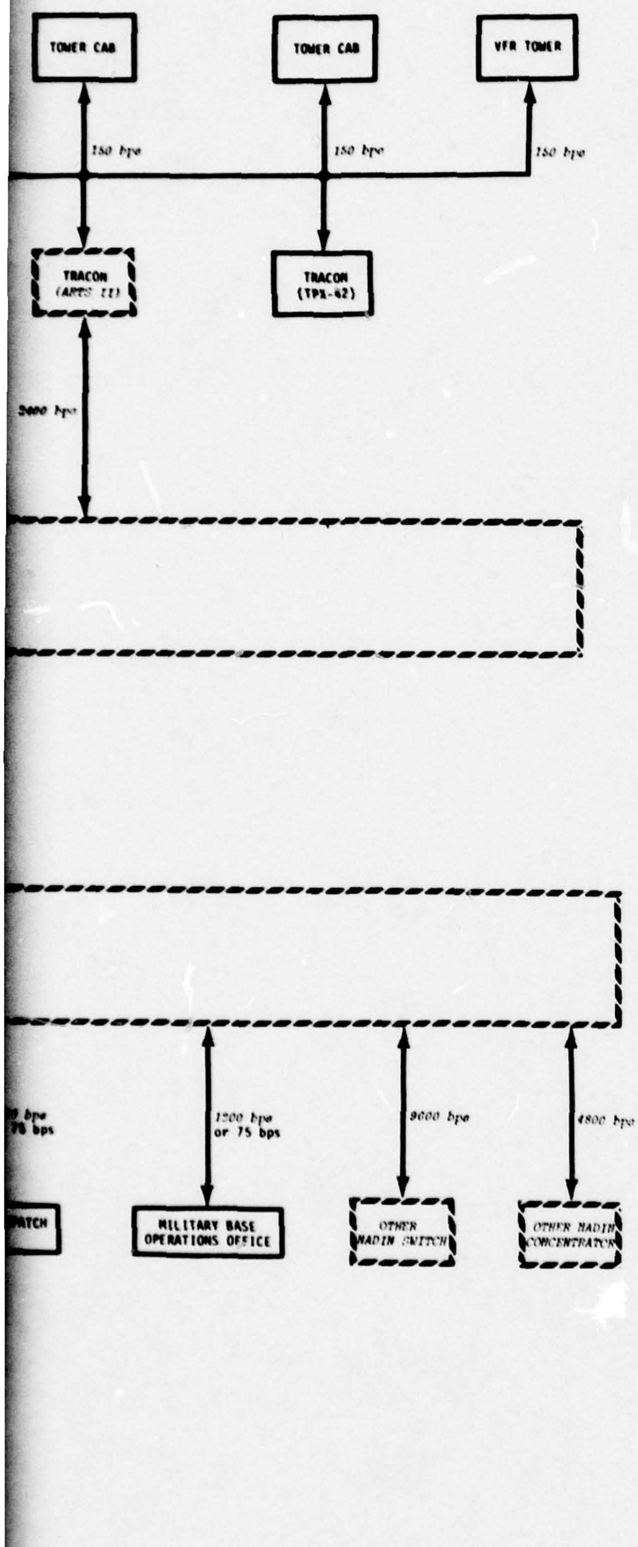
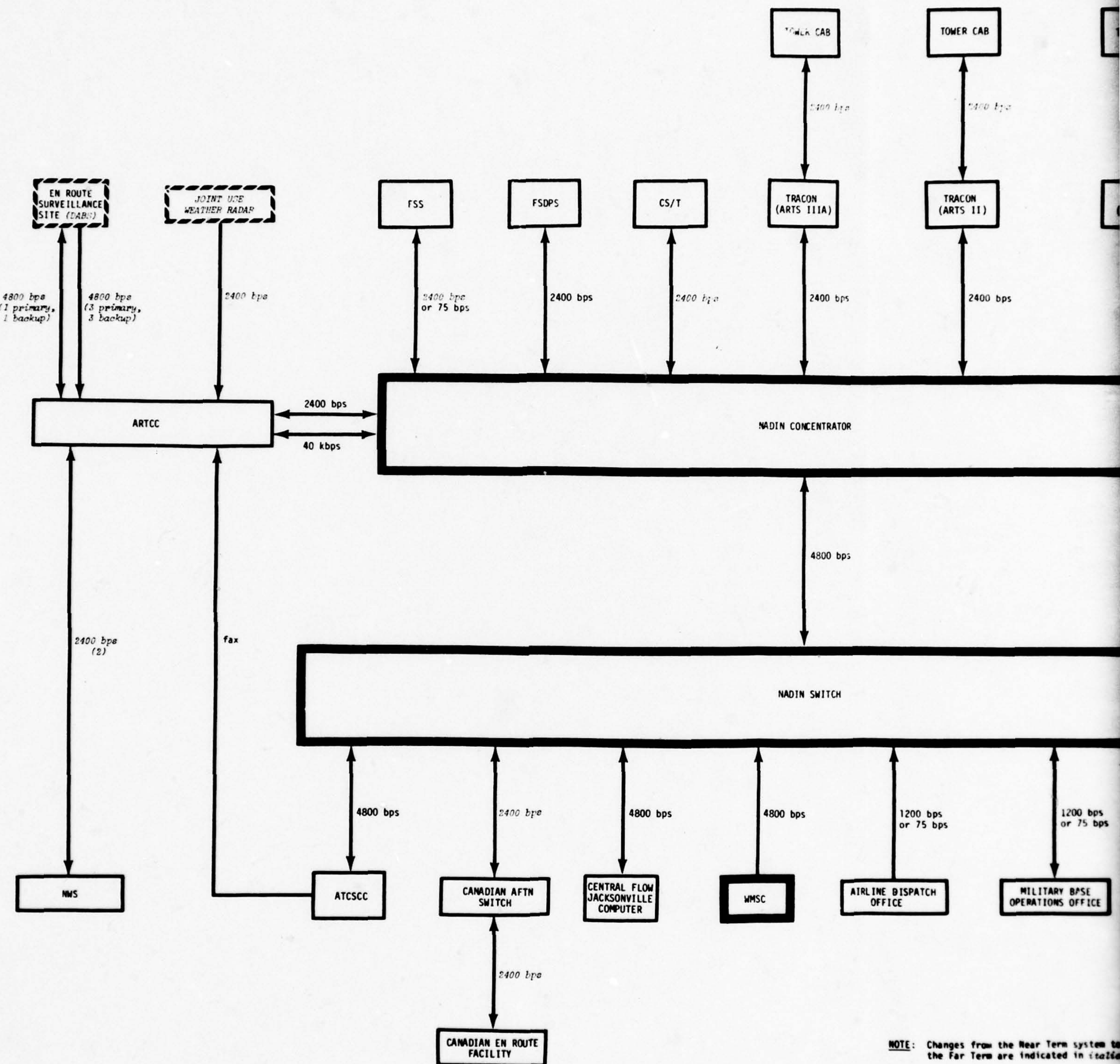
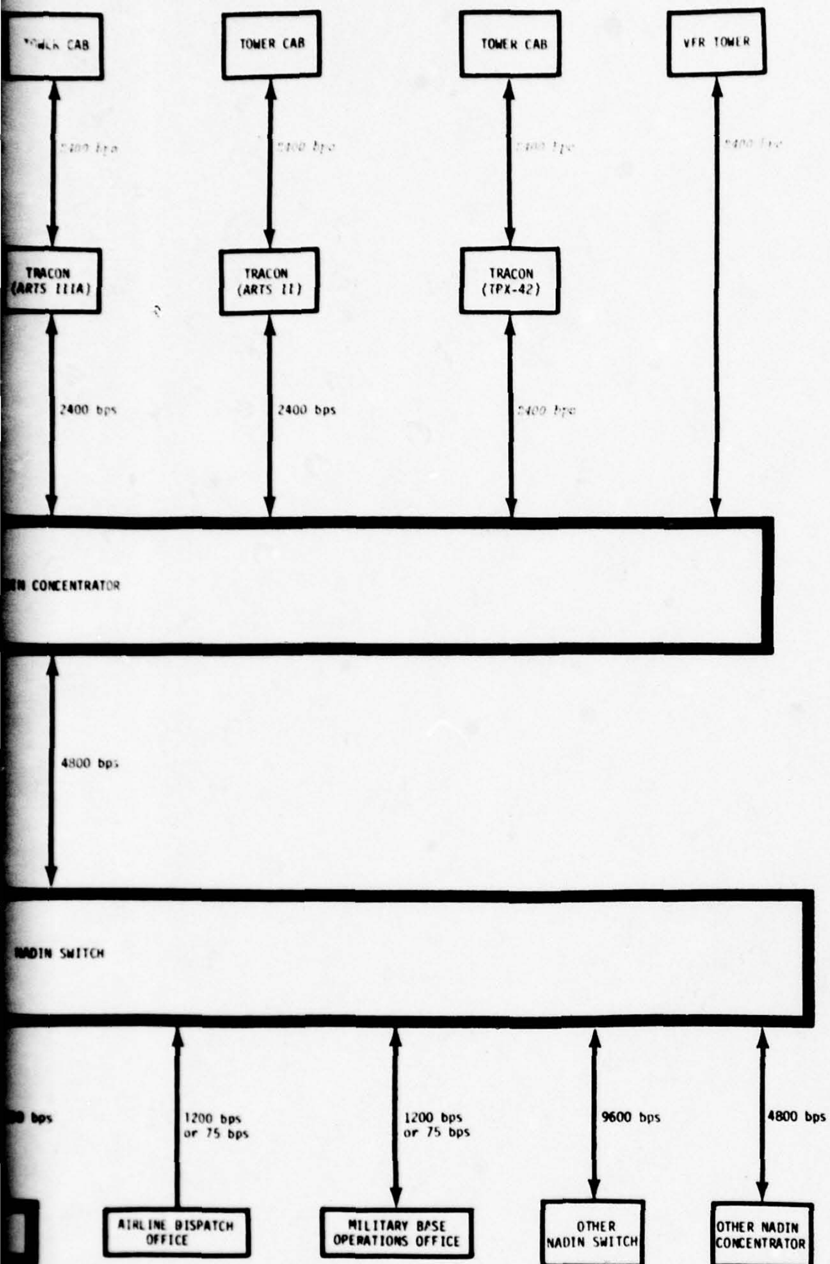


FIGURE 9-2
NEAR TERM EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

2



NOTE: Changes from the Near Term system to the Far Term are indicated in italics



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 9-3
FAR TERM EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

2

For surveillance data, the CD-2 and the ARSR-3 are introduced in Near Term, to replace the original CD. Both the CD-2 and the ARSR-3 provide completely redundant paths from the Data Transmission Groups (DTGs) at the surveillance site through the modems at each end, and the redundant telephone lines. The backup broadband radar service is discontinued in Near Term.

The facsimile service from NMC to a printer in each ARTCC remains the same in Near Term as in the current system.

Far Term En Route Facilities

NADIN III is introduced in the Far Term, but the ARTCC-ARTCC data transfer is the same as for the Near Term.

The transmission from ARTCC to all automated terminals (ARTS III, ARTS II and a replacement for the TPX-42) in the Far Term is via NADIN III and the Terminal Information Processing System (TIPS). TIPS replaces the FDEP equipment and acts as a front-end processor for the terminal processor. The TPX-42 is replaced with a programmable device, and interfaces with the ARTCC in the same manner as the ARTS III and the ARTS II. The ARTCC-VFR Tower "FDEP" data transfer is also via NADIN, but to a medium speed terminal.

The Discrete Address Beacon System (DABS) is introduced at surveillance sites in the Far Term. Transmission is via three dedicated 4800 bps channels with three identical channels serving as backup. Redundancy is provided through the modems at each end.

Data link from surveillance sites to ARTCCs is introduced in the Far Term. A dedicated 4800 bps channel, plus an identical redundant channel, are provided from the DABS processor to a front-end processor in the ARTCC.

The three teletypewriter networks (Area B, Utility B and Center B), which were replaced with NADIN in the Near Term, remain configured as in the Near Term.

The NMC facsimile circuit to the ARTCC is replaced with a 2400 bps dedicated circuit from AFOS. A second 2400 bps circuit is planned for redundancy.

Weather radar data from a nearby Joint Use Weather Radar facility are provided via a 2400 bps dedicated data channel.

9.1.1.2 TRACON/Tower Facilities - Improvements

The TRACON/Tower data communications are comprised of the following services; terminals to ARTCC, terminal to terminal, surveillance sites to terminals, automated terminals to satellite terminals, and FDEP data to terminals. Some basic assumptions which were used in describing the terminal data communications are listed in Table 9-3. The descriptions of the three periods of interest, Current, Near Term and Far Term, are contained in Table 9-4. An illustration of the configuration for each of the three time periods is shown in Figures 9-4, 9-5, and 9-6. Clarifying information is included in the next three subparagraphs.

Current TRACON/Tower Facilities

The terminal to ARTCC data transfer is described in Section 9.1.1.1, En Route Facilities.

Terminal to terminal data transfer is provided along some routes for what is known as "tower en route" control. Data is relayed through one or two en route computers. No additional transmission lines are required; the normal ARTS III to ARTCC and ARTCC to ARTCC channels are used.

TABLE 9-3
ASSUMPTIONS FOR TRACON/TOWER FACILITIES DATA COMMUNICATIONS

1. Data communications between an ARTCC and terminals (ARTS III, ARTS II, TPX-42, VFR tower) and vice versa, are the same. This is true in a general sense, but the messages flowing in one direction differ from those flowing in the opposite direction.

2. Tower en route operation occurs between adjacent terminals operating under the same or adjacent centers.

3. ARTS III terminals will use digitized radar in Far Term. All other terminal radar will be broadband.

4. The ARTS III terminals, which utilize digitized radar, will have digital displays.

5. Broadband radar will not be used when digitized radar is available. A decision on the retention of broadband radar as a backup has not been made.

6. In the Far Term, all ARTS III satellite towers will have digitized tower displays.

7. Transfer of digitized radar data to an ARTS III terminal is via four 4800 bps lines.

8. No redundancy is provided for the data channels from surveillance sites to terminals.

9. DABS is implemented at ARTS III sites only (not for ARTS II and TPX-42).

TABLE 9-3
ASSUMPTIONS FOR TRACON/TOWER FACILITIES DATA COMMUNICATIONS (CONCLUDED)

10. One 2400 bps channel, plus a redundant channel, are provided from DABS to ARTS III for data link.

11. All TRACONs (ARTS III, ARTS II and TPX-42) may have satellite towers.

12. Digitized weather radar will be provided in the Far Term for ARTS III only.

TABLE 9-4
TRACON/TOWER FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
1. ARTS III TERMINALS - ARTCC		SEE Table 9-2 Item 2	
2. ARTS II TERMINALS - ARTCC		SEE Table 9-2 Item 3	
3. TPX-42 - ARTCC		SEE Table 9-2 Item 4	
4. VFR TOWER - ARTCC		SEE Table 9-2 Item 5	
5. ARTS III - ARTS III (Flight Plan Data and Handoff Data)	Relay through an en route computer to transfer data between two ARTS III computers. The data transfer is over dedicated channels from the sending ARTS III computer to the en route computer (2400 bps) to another en route computer (2400 bps) to the receiving ARTS III computer (2400 bps) (full duplex). NOTE: The dedicated 2400 bps channel between an ARTS III computer and the local en route computer is the same one which is used for normal ARTCC/ARTS III data transfer.	NADIN II - Data transfer from ARTS III computer to NADIN concentrator (2400 bps), to NADIN switch (4800 bps), to a concentrator (4800 bps), then to another ARTS III computer (2400 bps) (full duplex).	NADIN III and TIPS (ARTS III) - Data transfer same as for NADIN II in Near-Term, except interface to ARTS III computer is via TIPS.

TABLE 9-4
TRACON/TOWER FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
6. SURVEILLANCE SITES ARTS III TERMINALS a. Broadband Search Radar and Beacon Data	FAA-owned Radar Microwave Link (RML) or coax cable from each airport surveillance site to the associated TRACON for transmission of broadband search radar and beacon data.	NC	Deleted
b. Digitized Search Radar, Weather Radar and Beacon Data	NA	NA	Four dedicated circuits (4800 bps each) from each DABS processor to a TRACON, for transfer of digitized search radar, weather data and beacon data (full duplex).
7. JOINT USE WEATHER RADAR SITE TO ARTS III TERMINALS	NA	NA	Dedicated circuit (2400 bps) from Radar site to transfer weather data to TRACON.

TABLE 9-4
TRACON/TOWER FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
8. ARTS III TERMINALS - SATELLITE TOWERS a. Tower BRITE Display Data	Data for the tower BRITE displays at satellite towers are transmitted from the TRACON over an RML or a coax cable (simplex).	NC	Deleted
b. Digitized Tower Display Data	NA	NA	One dedicated circuit (2400 bps) from the TRACON to the tower digital displays at a satellite tower (full duplex).
c. Weather Radar Data	NA	NA	Dedicated line (2400 bps) from ARTS III TRACON to associated tower to transfer weather data to tower.
9. SURVEILLANCE SITES-ARTS II TERMINALS Broadband Search Radar and Beacon Data	FAA-owned RML or coax cable from each airport surveillance site to the associated TRACON for transmission of broadband search radar and beacon data.	NC	NC

TABLE 9-4
TRACON/TOWER FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY
(CONCLUDED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST 1982)
10. ARTS II TERMINALS - SATELLITE TOWERS Broadband Tower BRITE Display Data	Data for the tower BRITE displays at satellite towers are transmitted from the TRACON over an RML or a coax cable (simplex).	NC	NC
11. RADAR SITES TPX-42 TERMINALS Broadband Search Radar and Beacon Data	FAA-owned RML or coax cable from each airport surveillance site to the associated TRACON for transmission of broadband search radar and beacon data.	NC	NC
12. TPX-42 TERMINALS - SATELLITE TOWERS Broadband Tower BRITE Display Data	Data for the tower BRITE displays at satellite towers are transmitted from the TRACON over an RML or a coax cable (simplex).	NC	NC
13. DATA LINK - ARTS III	NA	NA	One dedicated channel (2400 bps) from each DABS processor to an ARTS-III computer, via TIPS, for data link, plus an identical channel for backup (full duplex).

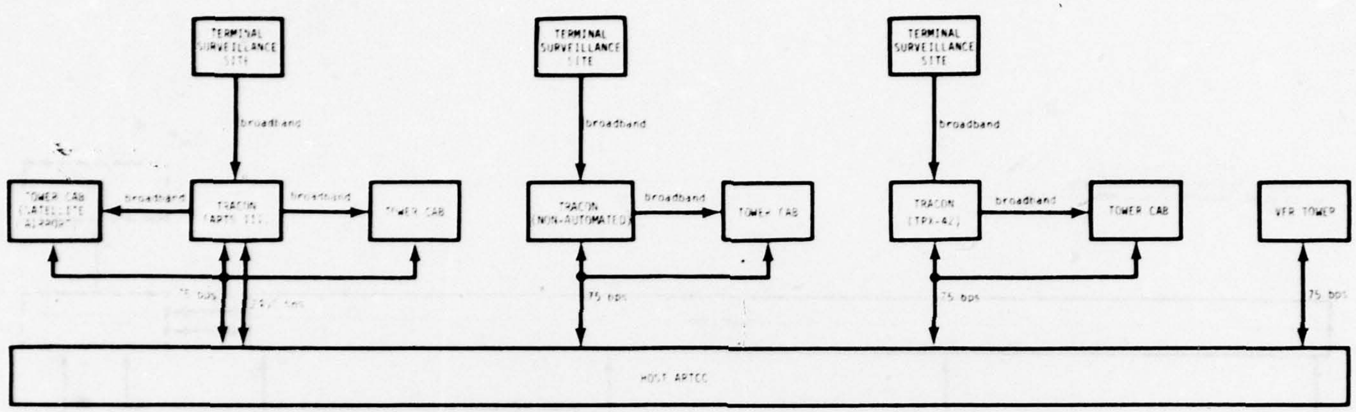


FIGURE 9-4
CURRENT TRACON/TOWER DATA COMMUNICATIONS
CONNECTIVITY DIAGRAM

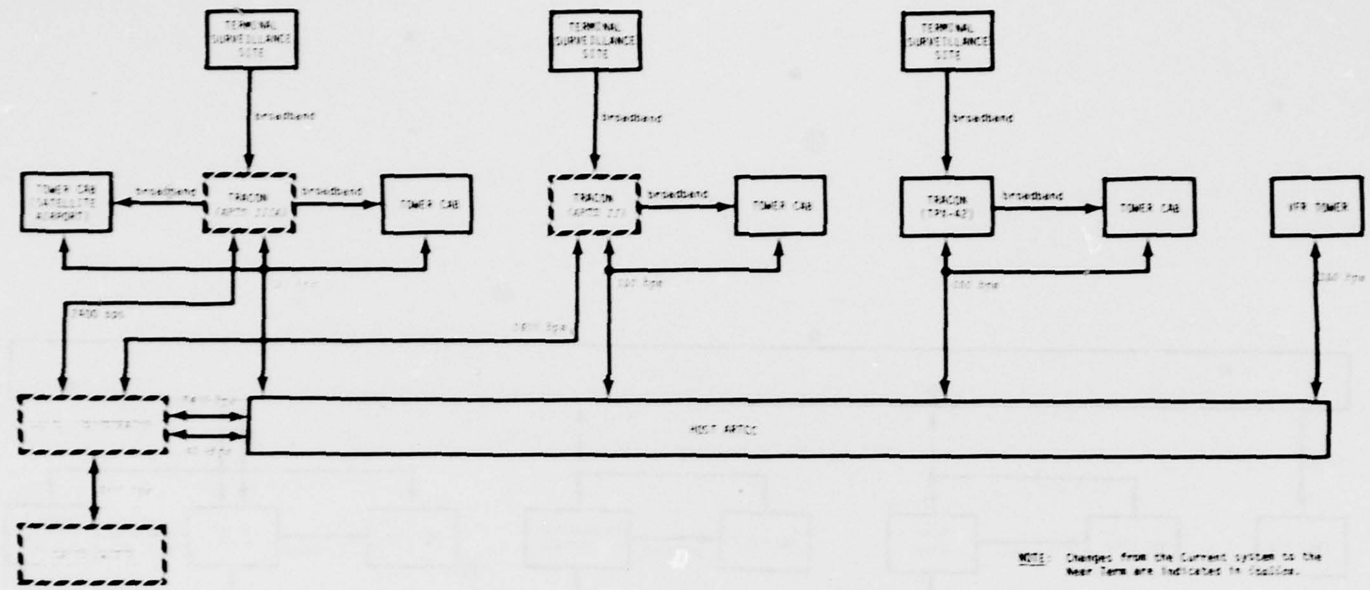


FIGURE 9-5
NEAR TERM TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

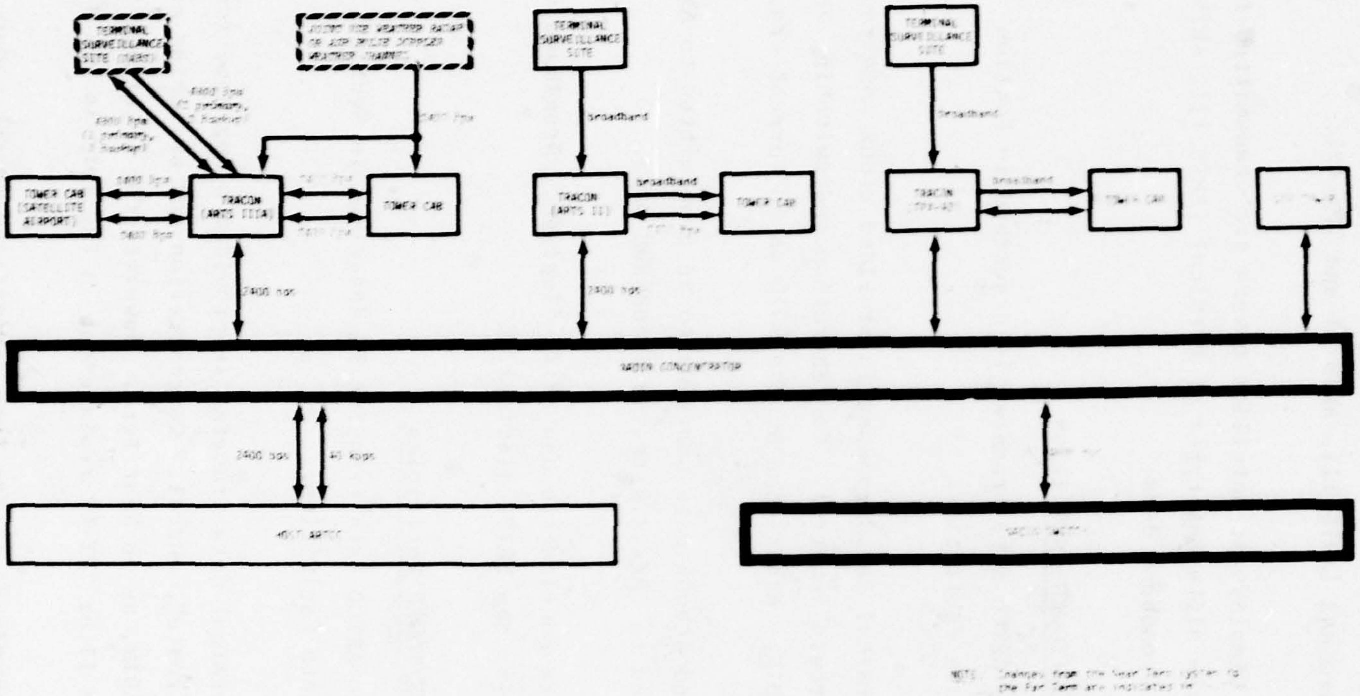


FIGURE 9-6
FAR TERM TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

Search radar beacon data are transmitted as broadband data to each type of terminal (ARTS III, ARTS II and TPX-42).

Data for BRITE displays at satellite towers are transmitted from each of the three different types of terminal (ARTS III, ARTS II and TPX-42) as broadband data.

Near Term TRACON/TOWER Facilities

The terminal to ARTCC data transfer is described in Section 9.1.1.1, En Route Facilities.

Terminal to terminal data transfer is provided along some routes for "tower en route" control. Concentration and switching are provided by NADIN, rather than by the 9020 as in current era.

Search radar and beacon data continue to be transmitted to ARTS III, ARTS II and to TPX-42 sites as broadband data.

Satellite towers continue to use BRITE displays. Broadband data is transmitted to the BRITE displays.

Far Term TRACON/TOWER Facilities

The terminal to ARTCC data transfer is described in Section 9.1.1.1, En Route Facilities.

Terminal to terminal data transfer is provided along some routes for "tower en route" control. Concentration and switching are provided by NADIN, as in Near Term. However, the interface to ARTS III, ARTS II or TPX-42 replacement in Far Term is via TIPS.

The DABS is introduced in Far Term. Digitized search radar,

weather radar and beacon data are transmitted from the surveillance sites to the ARTS III via four dedicated 4800 bps circuits.

Search radar and beacon data continue to be transmitted to ARTS II sites and to sites using a replacement for the TPX-42 as broadband data.

Satellite towers from an ARTS III facility have digital displays. One dedicated 2400 bps channel is used for transmission.

Satellite towers from ARTS II and TPX-42 replacement facilities continue to use BRITE displays. Broadband data is transmitted to the BRITE displays.

Data link service is provided from the DABS processor to the ARTS III processor, via TIPS. A dedicated 2400 bps channel is used for transmission, with a second 2400 bps channel provided for backup.

Joint use weather radar data are provided to the ARTS III TRACON and associated tower cab via a dedicated 2400 bps data channel.

9.1.1.3 ATCSCC Improvements

The ATCSCC (or SCC) data communications are comprised primarily of the following services: ARTCC to CFJC, CFJC to SCC, SCC to ARTCC and NWS to SCC. Some basic assumptions which were used in describing the ATCSCC data communications are listed in Table 9-5. The descriptions of the three periods of interest, Current, Near Term and Far Term are contained in Table 9-6.

TABLE 9-5
ASSUMPTIONS FOR ATCSCC FACILITY DATA COMMUNICATIONS

1. The SCC will remain on the Center B TTY network after the CFJC is installed, for transfer of flow control information from the SCC to ARTCCs.

2. The Airport Information Retrieval System (AIRS) will be replaced by the Central Flow Jacksonville Computer (CFJC) in the current time frame.

3. The CFJC interface with 5 selected ARTCCs over dedicated 2400 bps lines will take place in the current time frame.

4. The CFJC interface with the SCC over two dedicated 4800 bps lines will take place in the current time frame.

TABLE 9-6
ATCSCC FACILITY - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
1. ARTCC-CFJC	One dedicated circuit (2400 bps) from CFJC to each of five selected ARTCCs for transfer of flow control messages to the CFJC (full duplex). NOTE: Transfer of flow control messages from the remaining 15 ARTCCs to the five ARTCCs which interface with the CFJC is over the normal center-to-center data channels.	NADIN II - Data transfer from en route computer to NADIN concentrator (up to 40 kbps), to NADIN switch (4800 bps), then to CFJC (4800 bps), and vice versa (full duplex).	NADIN III - Data transfer same as for NADIN II in Near Term.
2. CFJC-SCC	Two dedicated circuits (4800 bps each) for transfer of flow control messages from CFJC to SCC (full duplex).	NADIN II - Data transfer from CFJC computer to NADIN switch (4800 bps), then to SCC (4800 bps), and vice versa (full duplex).	NADIN III - Data transfer same as for NADIN II in Near Term.

TABLE 9-6
ATCSCC FACILITY - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY
(CONTINUED)

FUNCTIONS	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
3. SCC-ARTCC a. Flight movement directives	Center B TTY Network (75 bps) for transfer of flow control directives from SCC to each ARTCC (half duplex).	NADIN I - Data transfer from one of several terminals at SCC to a concentrator (75 to 2400 bps), to NADIN swtich (4800 bps), to NADIN concentrator (4800 bps), then to a terminal at ARTCC (2400 bps) or to the 9020 computer (up to 40 kbps) (half duplex).	NADIN III - Data transfer same as for NADIN I in Near Term.
b. Satellite Maps	One dedicated telephone line to each of 14 ARTCCs to carry facsimile of satellite pictures from SCC (simplex).	NC	NC

TABLE 9-6
ATCSCC FACILITY - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY
(CONCLUDED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
4. NWS-SCC a. Weather Radar	Three dial-up telephone lines to carry data from 30 radar sites to a thermofax printer in the SCC (simplex).	NC	NC
b. Weather Charts	Facsimile circuit to carry charts of upper air conditions to SCC from NMC (simplex).	NC	NC
c. Satellite Maps	Dedicated telephone line to carry satellite pictures to SCC from NOAA's National Environmental Satellite Service (simplex).	NC	NC
d. High Winds	850 bps circuit to carry forecasts of high winds to the SCC from the Severe Weather Labs (simplex).	NADIN I - Transfer of high winds forecasts from Severe Weather Labs to NADIN switch (4800 bps), to concentrator at the SCC (4800 bps) (full duplex).	NADIN III - Data transfer same as for NADIN I in Near Term.
5. SCC - FSS	Area B TTY Network (75 bps) for transfer of flow control directives to various FSSs (half duplex).	NADIN I - Data transfer from one of several terminals at SCC to a concentrator (75 to 2400 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps) then to FSS (75 bps) (half duplex).	NADIN III - Data transfer same as for NADIN I in Near Term.
6. WMSC-SCC	Service A Network (1200 bps) for transfer of weather data to ATCSCC.	NADIN II - Data transfer from WMSC to NADIN switch (4800 bps) then to ATCSCC (4800 bps) (half duplex).	NC

An illustration of the configuration for each of these time periods is shown in Figure 9-7, and 9-8. The configuration for Far Term communications is the same as that for Near Term communications. Clarifying information is contained in the following three subparagraphs.

Current ATCSCC Facilities

Flow control information is provided to the CFJC from five selected ARTCCs. A dedicated 2400 bps channel is provided from each of the five ARTCCs to the CFJC. Flow control data from the other 15 ARTCCs are transmitted to these five ARTCCs, using the normal ARTCC-ARTCC data channels for relay to the CFJC.

Two dedicated 4800 bps channels are provided for transfer of flow control data from the Central Flow Jacksonville Computer (CFJC) to the SCC.

Two transmission paths are provided from SCC to ARTCC; (1) Center B network for transfer of flow control information from SCC to ARTCC, and (2) dedicated telephone line for facsimile transmission of satellite weather pictures from SCC to 14 ARTCCs. Flow control information to FSSs is sent via the Area B network.

Weather data from NWS (WX radar, WX charts, satellite maps, WX forecasts and high winds forecasts) are transmitted over dedicated facsimile lines and a high speed teletype circuit. Radar data from 30 weather radar sites is accessed via 3 dial up facsimile circuits.

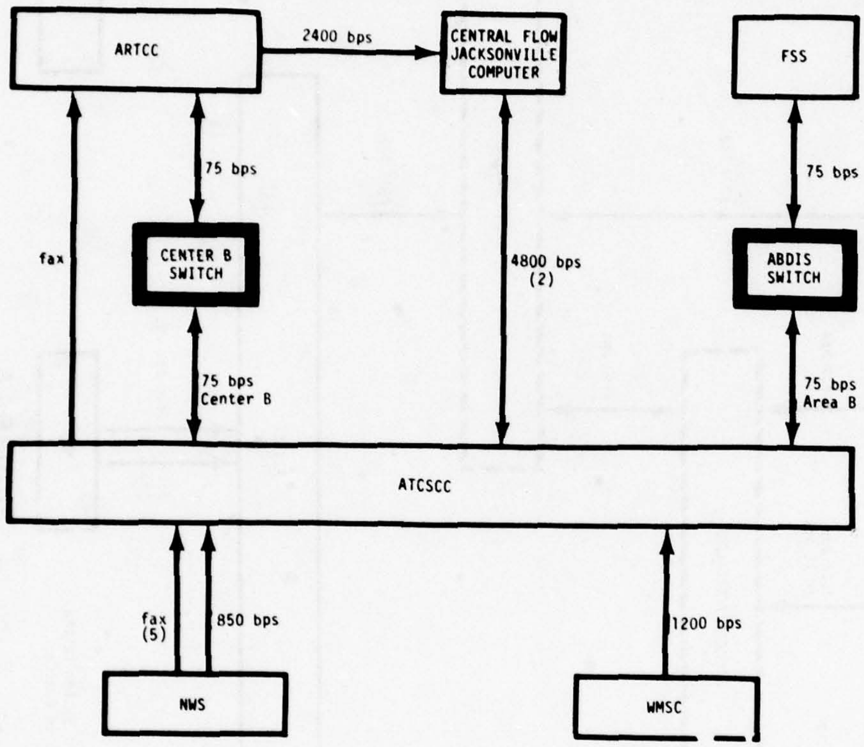
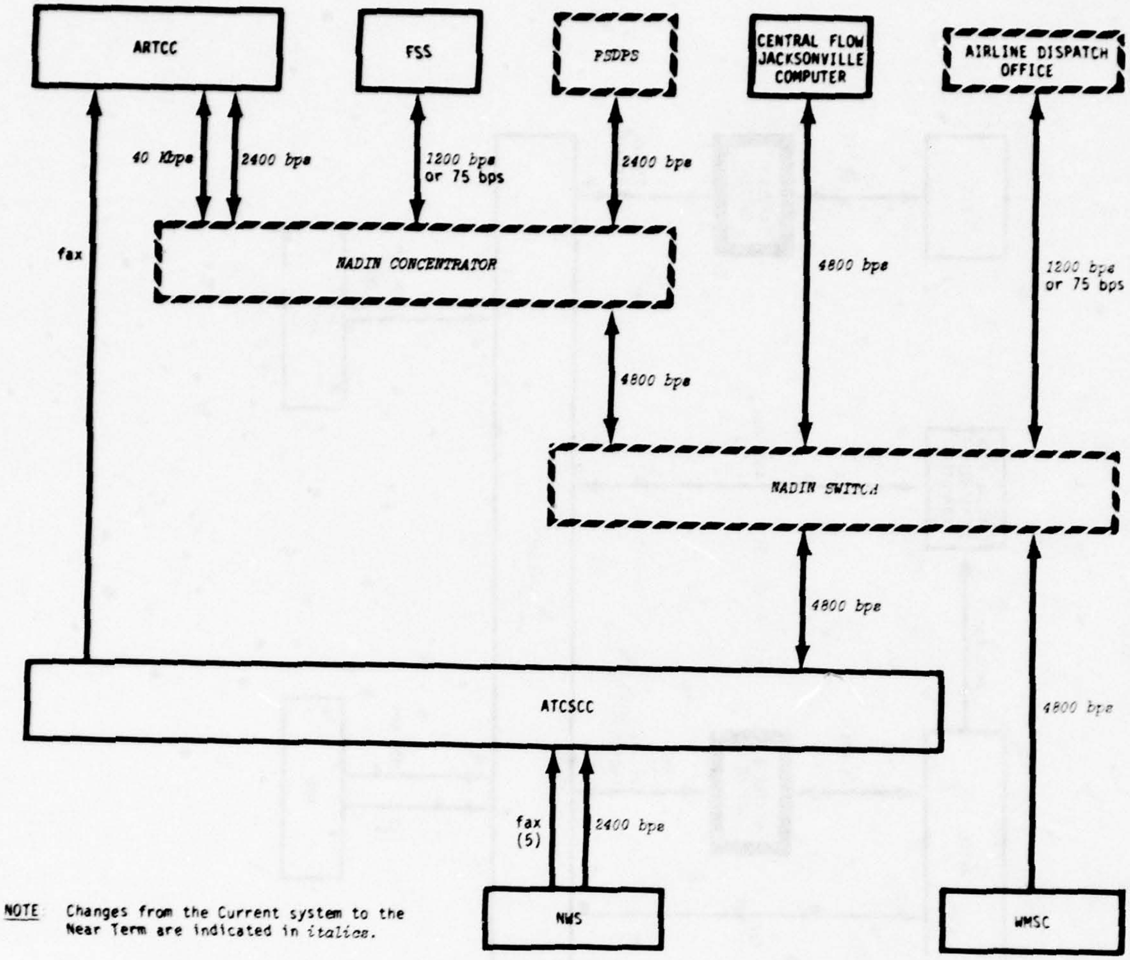


FIGURE 9-7
CURRENT ATCSCC DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 9-8
NEAR TERM ATCSCC DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

Near Term ATCSCC Facilities

The Center B teletype network in the current system is replaced with NADIN. The dedicated telephone line is retained at each of 14 ARTCCs for facsimile transmission of satellite weather maps.

Flow control data from each ARTCC is sent to the CFJC through NADIN. Transfer of flow control data from CFJC to SCC is via NADIN without going through concentrators. This traffic will divide between the two NADIN switches.

The weather radar, weather charts and satellite maps continue to be sent from NWS as in the current system. However, the weather forecasts from WMSC and the highwinds forecasts from Severe Weather Labs are handled by NADIN.

Far Term ATCSCC Facilities

All data transfer in Far Term is the same as in Near Term, except that NADIN III replaces NADIN II.

9.1.1.4 Flight Service Facility Improvements

The FSS data communications are primarily involved in the accumulation and organization of a weather data base, interactive communications with user terminals and the filing of flight plans and transmission of various administrative messages. Some basic assumptions used in describing the FSS data communications are listed in Table 9-7. Descriptions of the three periods of interest, Current, Near Term and Far Term are provided in Table 9-8. Illustrations of the connectivity required in each time period are shown in Figures 9-9, 9-10 and 9-11 respectively. Some discussion is included in the following subparagraphs.

TABLE 9-7
ASSUMPTIONS FOR FLIGHT SERVICE FACILITIES DATA COMMUNICATIONS

1. NADIN I - Including all Area B, Mil B, Air B, Utility B, and US AFTN subscribers and with connections to WMSC, NWS, NAS 9020s, and International AFTN - is assumed in Near Term. Model 1 FSS including AFSSs and FSDPS are included in the Near Term.

2. NADIN II - Including in addition to the above, all Service A subscribers, CFJC and ATCSCC - is also assumed in Near Term.

3. NADIN III - Including all the above and communications in support of the AWP are assumed to be Far Term.

4. NADIN III is assumed to be coincident with AWP.

TABLE 9-8
WEATHER AND FLIGHT SERVICE FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
1. WMSC - FS Facility			
a. Weather data gathering	FSS to WMSC Service A Network - 75 bps multipoint circuits from all FSSs, and other FAA weather collection points	AFSS to WMSC NADIN II - Data transfer from AFSS to FSDPS (via dedicated lines at various rates) to NADIN concentrator (1200 bps), to NADIN switch (4800 bps) then to WMSC (4800 bps).	FSDPS to WMSC NADIN III - Data transfer from FSDPS to NADIN concentrators (4800 bps) to NADIN switch (4800 bps), then to WMSC (4800 bps). The NADIN switch will simultaneously send a duplicate copy of each item to the AWP (4800 bps).
		FSS and other FAA collection points to WMSC NADIN II - Data transfer from collection points to NADIN concentrators (various rates), to NADIN switch (4800 bps) then to WMSC (4800 bps).	NC
b. Distribution of Weather Products	WMSC to FSSs Service A Network - 75 bps multipoint circuits to all FSSs.	WMSC to AFSS NADIN II - Data transfer from WMSC to NADIN switch (4800 bps), to NADIN concentrators (4800 bps), to FSDPSs (1200 bps), then to AFSSs (via dedicated lines at various rates) as requested.	WMSC to AFSS NADIN III - Data transfer from WMSC to NADIN switch (4800 bps) to AWP (4800 bps), to NADIN switch (4800 bps) to NADIN concentrator (4800 bps) then to FSDPS (4800 bps), and then to AFSS (via dedicated lines at various rates) in response to requests.
	WMSC to other weather users Service A Network - various rate circuits (up to 2400 bps) to weather users.	WMSC to FSSs and other users NADIN II - Data transfer from WMSC to NADIN switch (4800 bps) to NADIN concentrators (4800 bps) to FSSs and other users (various rates).	WMSC to other weather users NADIN III - Data transfer from WMSC to NADIN switch (4800 bps) to NADIN concentrators (4800 bps) then to FSSs and other weather users (various rates).
2. WMSC - ARTCC Weather Products	WMSC - ARTCC Service A Network Request/Reply service (75 bps) to provide requested weather data to ARTCC. (Half duplex)	WMSC - ARTCC NADIN II - Request from ARTCC to NADIN concentrator (2400 bps), to NADIN switch (4800 bps) then to WMSC (4800 bps). Reply follows reverse path.	WMSC - ARTCC NADIN III - Request from ARTCC to NADIN concentrator (2400 bps) to NADIN switch (4800 bps) then to WMSC (4800 bps). Reply follows reverse path.

TABLE 9-8
WEATHER AND FLIGHT SERVICE FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY (CONTINUED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
3. WMSC - National Weather Service Exchange of weather data (alphanumeric data only).	WMSC to/from NMC Service A Network - 2400 bps circuit from WMSC to National Meteorological Center	WMSC to NMC NADIN I - Data transfer from WMSC to NADIN switch (4800 bps) then to NMC (2400 bps) and vice versa	NC
	WMSC to/from WSFOs Service A Network - 75 bps multipoint circuits from WMSC to all Weather Service Forecast Offices	Deleted	NC
4. NMC - FS Facility Weather Maps	NMC to FSS Leased facsimile circuits to distribute weather maps.	NMC to FSS NC	NMC to FSS NC
		NMC to AFSS Leased facsimile circuits to distribute weather maps.	NMC to AFSS Deleted (Weather maps included in data base)
5. AWP - NWS Weather maps (graphic data to AWP)	NA	NA	Leased line - 2400 bps circuit from NWS to AWP.
6. FSDPS - DUATS Interactive access to weather data base for weather briefings and filing of flight plans.	NA	NA	Dedicated lines - 2400, 4800 and 9600 bps channels to allow users to access the FSDPS. Up to 3 user terminals will share each line. Dial-in ports (300 and 1200 bps) allow some users to access the FSDPS. Only one user terminal can use a dial-in line at a time.
7. FSDPS - Weather Radars Weather Radar Data	NA	NA	Dial-up ports (2400 bps) to allow entry of graphic data from the Weather Radars.

TABLE 9-8
WEATHER AND FLIGHT SERVICE FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY
(CONCLUDED)

FUNCTION	CURRENT (1978)	NEAR TERM (1979-82)	FAR TERM (POST-1982)
8. FS Facility - ARTCC Entry of IFR flight plans, etc.	AFSS to ARTCC NA	AFSS to ARTCC Message transfer from AFSS to FSDPS (dedicated lines at various rates), to NADIN I concentrator (1200 bps), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps) then to 9020 Processor (up to 40 kbps).	AFSS to ARTCC NC
	FSS to ARTCC Area B Network - Message transfer from FSS to ABDIS switch (75 bps multipoint) then to ARTCC manual position (75 bps) for formatting and processor entry.	FSS to ARTCC NADIN I - Message transfer from FSS to NADIN concentrator (75 bps) to NADIN switch (4800 bps) to NADIN concentrator (4800 bps) then to ARTCC manual position (2400 bps) for formatting and entry into the 9020 Processor.	FSS to ARTCC NC
9. FS Facility - Other ARTCCs, other FSDPSs, Mil Base Ops, CFJC, ARTSCC, Records Center, NATCOM, Aeronautical Center NAFEC, etc.			
Miscellaneous Communications to file or update VFR flight plans, to access remote data bases, and for miscellaneous other messages.	AFSS to destination NA	AFSS to destination Message transfer from AFSS to FSDPS (dedicated lines at various rates), to NADIN I concentrator (1200 bps), to NADIN switch (4800 bps) to NADIN concentrator (4800 bps), then to destination (via a destination compatible circuit) and vice versa.	AFSS to destination NADIN III - Message transfer from AFSS to FSDPS (dedicated lines at various rates) to NADIN concentrator (4800 bps), to NADIN switch (4800 bps), to NADIN concentrators (4800 bps), to destination (via a destination compatible circuit).
	FSS to destination Area B Network - Message transfer from FSS to ABDIS switch (75 bps multipoint) then to destination (on a destination compatible circuit) and vice versa.	FSS to destination NADIN I - Message transfer from FSS to NADIN concentrator (75 bps multipoint), to NADIN switch (4800 bps), to NADIN concentrator (4800 bps), then to destination (via a destination compatible circuit) and vice versa. (ATCSCC and CFJC are terminated in NADIN switch)	FSS to destination NC

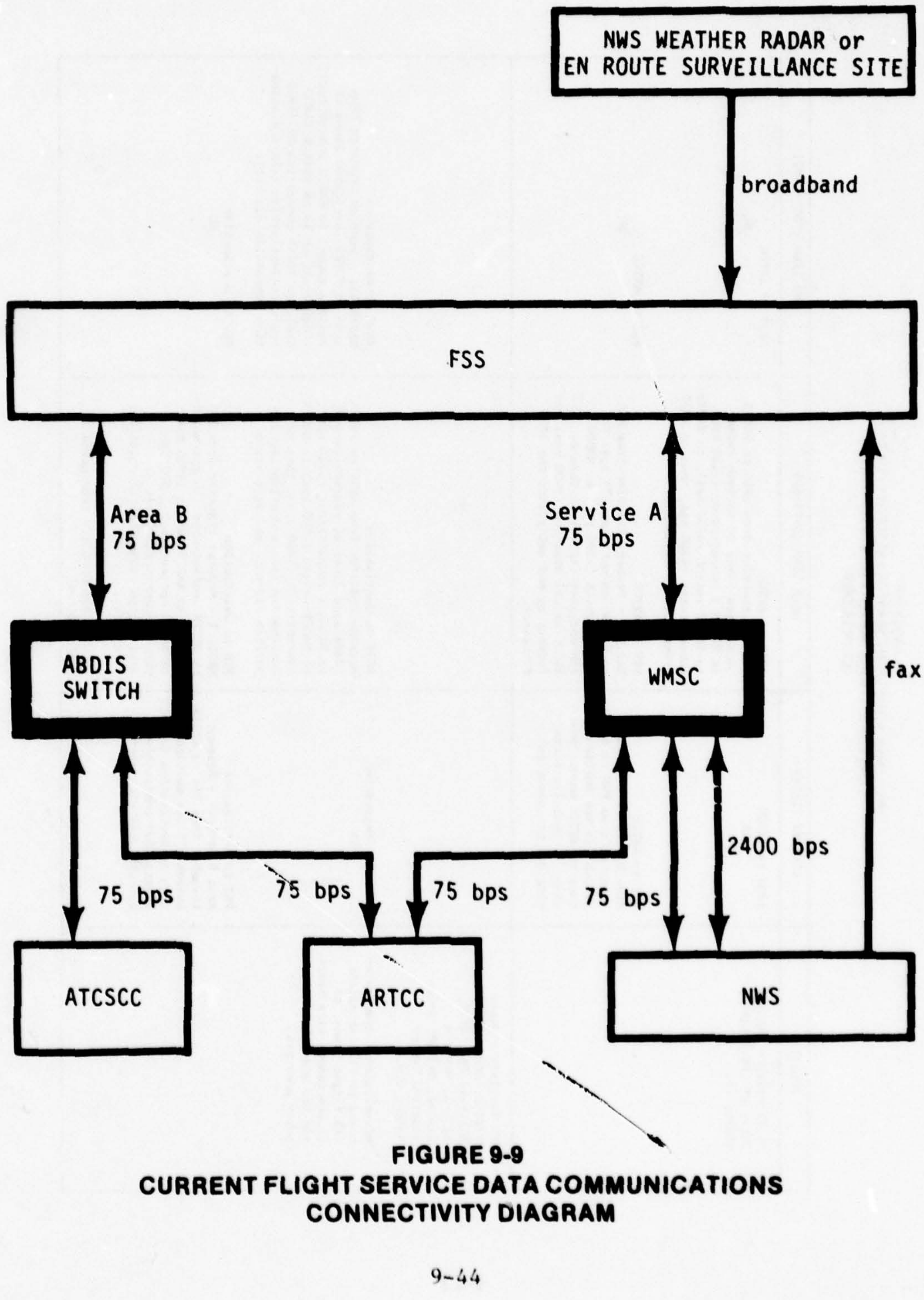
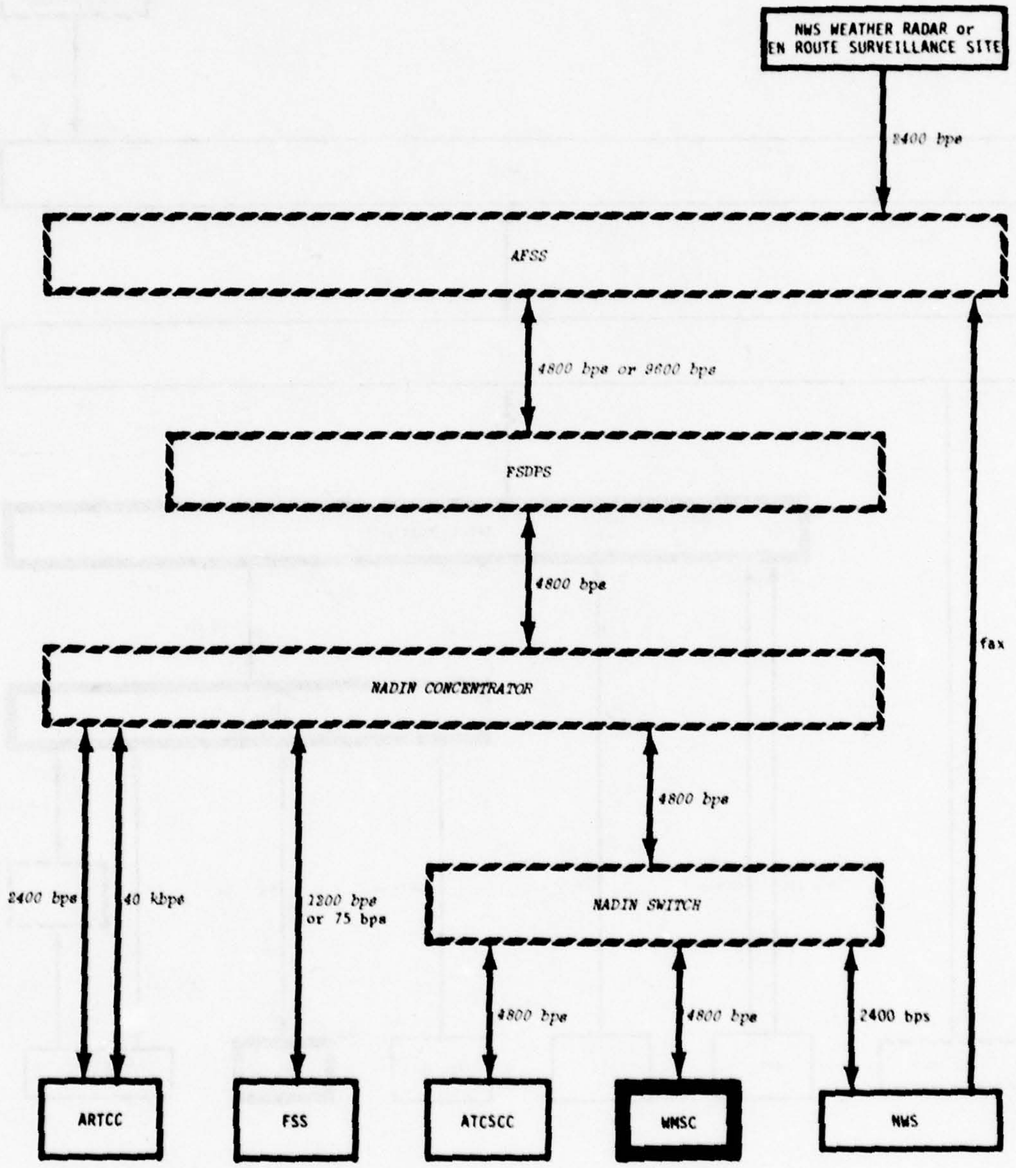
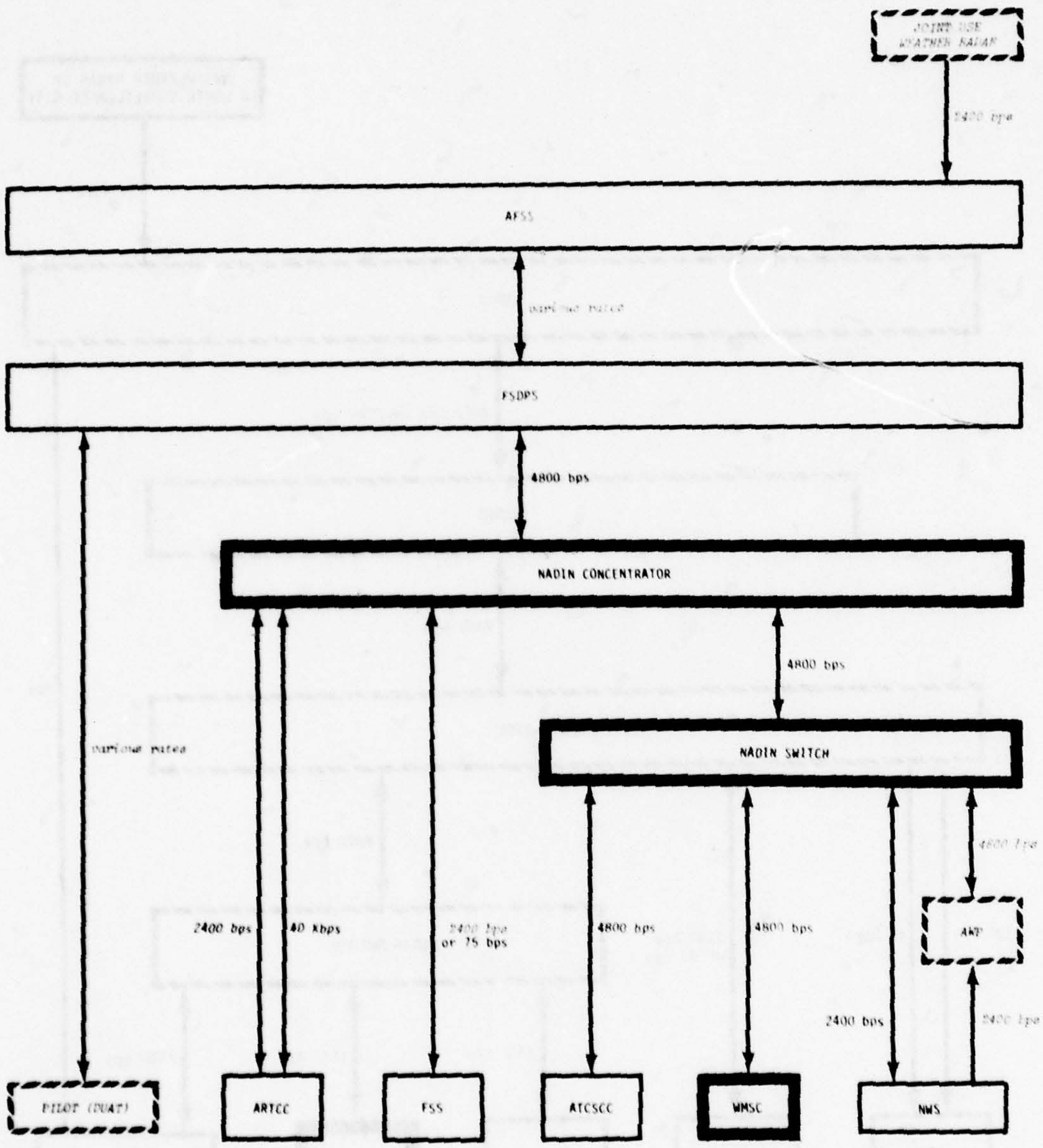


FIGURE 9-9
CURRENT FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 9-10
NEAR TERM FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 9-11
FAR TERM FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

Current Flight Service Facilities

In the Current systems, Figure 9-9, the Weather Message Switching Center (WMSC) collects weather data from FSSs, from the National Weather Service - National Meteorological Center, from Weather Service Forecast Offices (WSFO), and from other collection points. These data are organized and transmitted to all FSSs. This is the basic purpose of "Service A." These data are maintained in the FSSs on clipboards and are referred to in the briefings of pilots requesting information.

Pilots generally request information over the counter (OTC) or by telephone, and therefore do not represent users of data communications.

Once flight plans are prepared, they are filed into the ARTCC (IFR) or to the destination FSS (VFR) through the Area B network.

Weather maps from NWS, and information from nearby radar sites, are obtained via dedicated facsimile circuits tailored to the needs of their specialized function.

Near Term Flight Service Facilities

In the Near Term, Figure 9-10, it is expected that some of the FSSs will be automated (AFSS) through access to centralized Flight Service Data Processing Systems (FSDPS).

Also during this time period, NADIN will be implemented and take over the functions of Service A and Area B in accumulating the weather data and in filing flight plans.

Far Term Flight Service Facilities

The Far Term will see the culmination of the flight service automation program (Figure 9-11). In this time period, the FSS functions will be automated into a series of 20 FSDPSs, one located at each of the conterminous ARTCCs. The weather data base will be organized by the combination of the WMSC and an Aviation Weather Processor (AWP). Weather observations will continue to be made primarily by personnel at FSS facilities. Data communications for these system elements will be provided by NADIN.

Pilot access to the FSDPS will be through a dial up voice response system (VRS), through the use of data terminals or through a series of AFSSs equipped with data terminals. The data terminals at busy locations will be served on a multipoint basis via dedicated lines. The use of dedicated lines is dictated by the interactive nature of the service. The VRS and dial-in data service connections (to lightly loaded terminals) will be provided through the commercial telephone system.

9.1.2 NADIN Configuration and Functions

The current FAA data communications capability is characterized by the use of a number of separate independent networks. Efforts are currently underway to combine these separate capabilities into a single network, NADIN, which will meet the varied needs of present FAA operations and provide capacity for growth to accommodate future requirements as they develop. This section will describe the current networks, the NADIN concept and how NADIN will meet the FAA needs for data communications.

9.1.2.1 Current Data Communications Network

Current FAA data communications are illustrated in Figure 9-12. Each network (Area B, Center B, NASNET, Service A, AFTN, etc.) is shown together with the primary facilities served and the element which controls it. Although most of the networks are teletypewriter networks, there is, in general, no automatic interconnection between them. The principle characteristics of these networks are listed below.

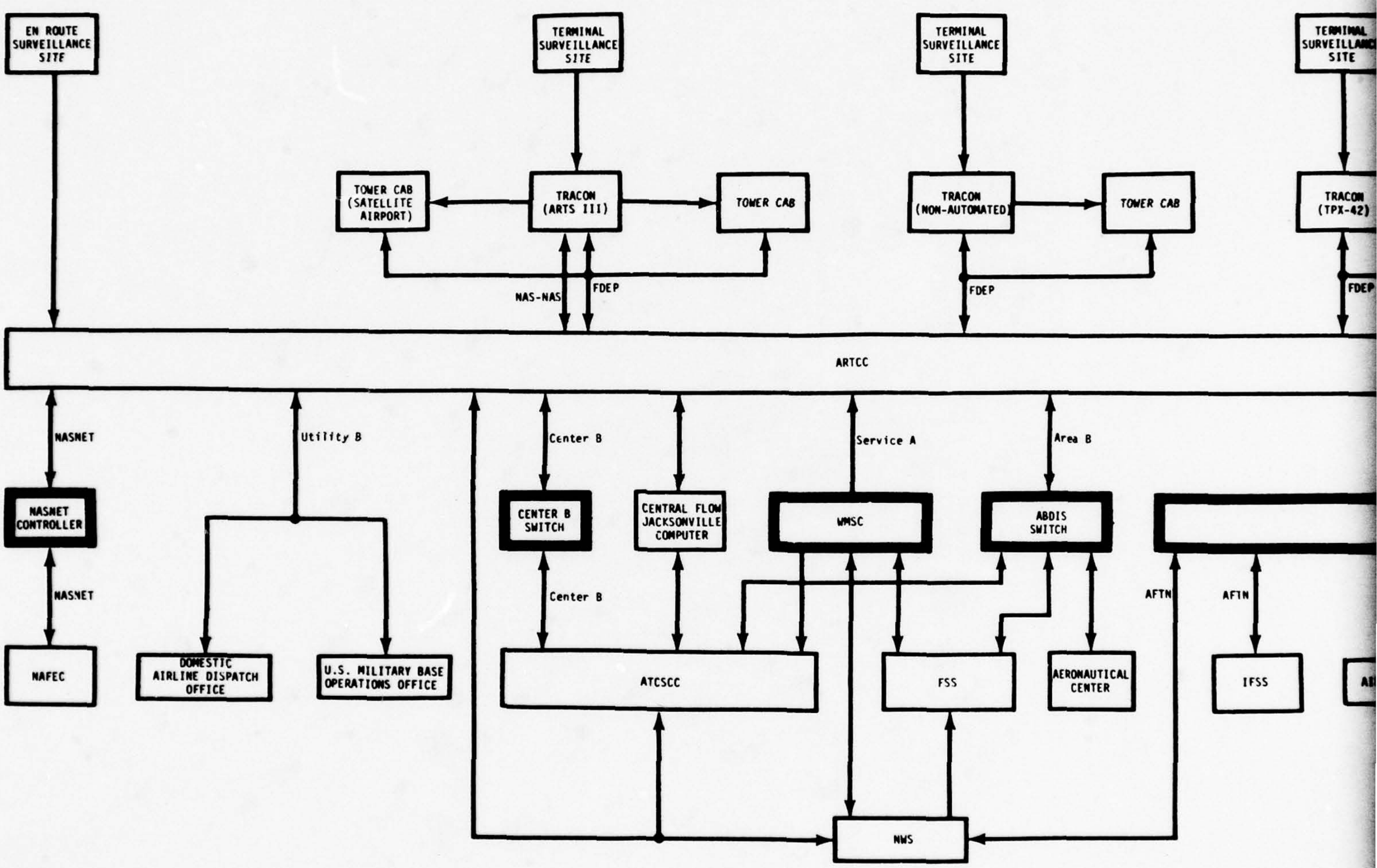
Area B and Supplemental Circuits

The Area B network is generally used for exchanging flight planning information and various types of administrative messages. The network consists of 24 multipoint circuits terminating over 300 terminals located at FSSs, CS/Ts, ARTCCs and other FAA facilities. All terminals are Model 28 series teletypewriters or compatible equipments. Control of each circuit as well as exchange of traffic between circuits is performed by the Automated Service B Data Interchange System (ABDIS) located at Kansas City, Missouri.

Supplemental B circuits are provided to relieve the high traffic load at certain high density Area B terminations. In general, the terminal equipments are Model 28 receive-only (R/O) teletypewriters.

Center B

The Center B network interconnects the 20 ARTCCs within the conterminous U.S., and is used for the interchange of flight movement information. The network consists of two circuits: one interconnecting the western ARTCCs, the other the eastern ARTCCs. All terminals are Model 28 teletypewriter equipments.



EN ROUTE SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TOWER CAB (SATELLITE AIRPORT)
TRACON (ARTS III)
TOWER CAB
TRACON (NON-AUTOMATED)
TOWER CAB
TRACON (TPX-42)
NAS-NAS
FDEP
FDEP
FDEP
ARTCC
NASNET
Utility B
Center B
Service A
Area B
NASNET CONTROLLER
CENTER B SWITCH
CENTRAL FLOW JACKSONVILLE COMPUTER
WMSC
ABDIS SWITCH
NASNET
Center B
AFTN
AFTN
NAFEC
DOMESTIC AIRLINE DISPATCH OFFICE
U.S. MILITARY BASE OPERATIONS OFFICE
ATCSCC
FSS
AERONAUTICAL CENTER
IFSS
NWS

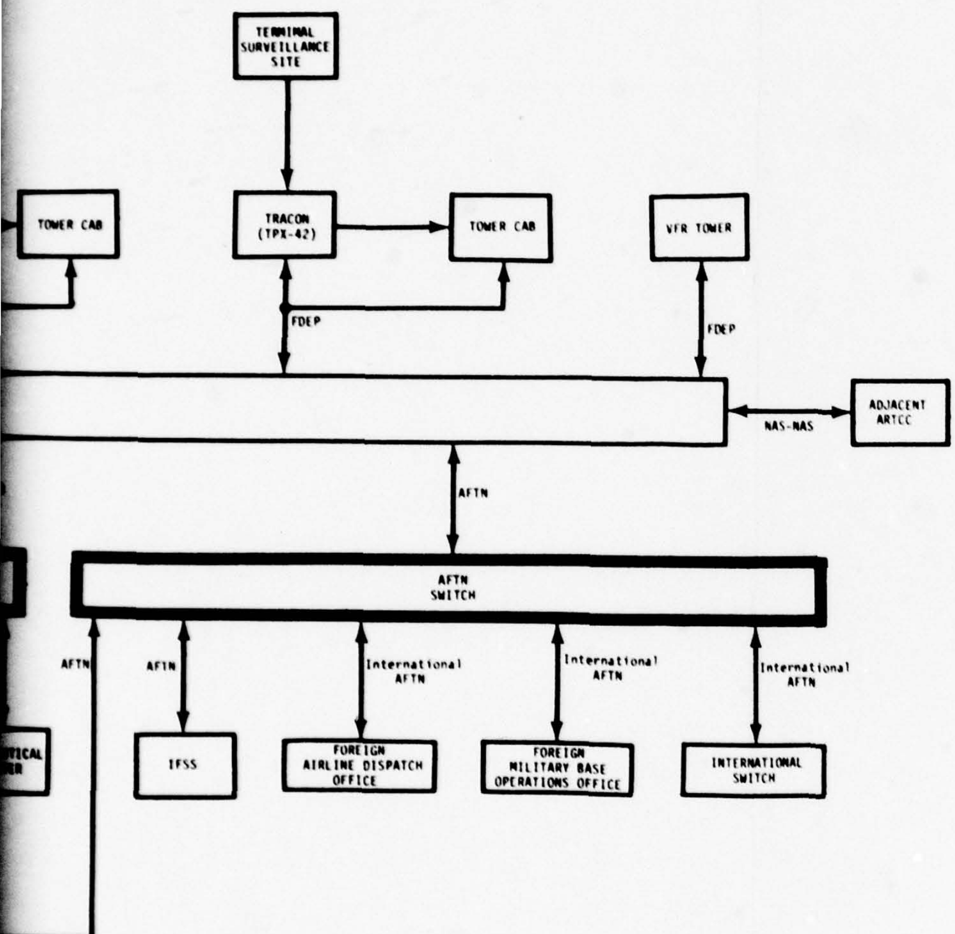


FIGURE 9-12
CURRENT DATA COMMUNICATIONS

2

Control of the circuits and interchange of traffic between them is handled by an automatic switch at NATCOM in Kansas City, Missouri.

NASNET

Another teletypewriter network is the NASNET which interconnects the automated ARTCCs with NAFEC. This network is used for the exchange of information pertinent to the operations of the en route automation computers. The network consists of a single multipoint circuit and a controller located at NATCOM in Kansas City, Missouri.

Service A

The Service A network interconnects teletypewriters and some medium speed (1200 or 2400 bit per second) terminals at facilities which collect or use weather data. The network is specialized in that it handles only weather data. Weather observations and related messages are prepared at FSSs on punched paper tape and are inserted in the teletypewriter's tape reader. The Weather Message Switching Center (WMSC) polls these stations and collects their reports. The WMSC then organizes this weather data and distributes it to user locations. Some users, such as the ARTCCs have Request/Reply (RR) service which allows them to obtain specific weather information on request.

AFTN

The Aeronautical Fixed Telecommunications Network (AFTN) provides for the exchange of international aircraft movement information, administrative messages, and meteorological data between locations in the U.S. and in the International Civil Aviation

Organization (ICAO) member nations. The terminals are Model 28 teletypewriter equipment, but they use a code which is slightly different than that used commonly in the United States.

While the AFTN is international, the United States operates switching centers at Kansas City, Anchorage and Honolulu. The AFTN switch at NASCOM, Kansas City, is a major one providing the interconnection between some 39 circuits to points in the conterminous U.S., and additional circuits to Miami, San Juan and Balboa to serve the Caribbean and trunk circuits to Hawaii, Alaska, Montreal, Lisbon and Mexico City.

Utility B

Utility B circuits are a combination of the circuits previously known as Military B and Carrier B. They are used for filing flight plans and for general coordination between the centers and the principal users. The terminals are Model 28 teletypewriter equipment. The NAS 9020 processors are programmed to provide control of the Utility B circuits within their area of operations.

FDEP

FDEP circuits terminated at each center provide for the entry of flight plans and the distribution of flight strips to TRACONs and Towers within the center's area of coverage. The terminals operate in a mode and at a rate similar to teletypewriters, however the code is the EBCDIC code used in the en route automation processors. Control of these circuits is provided by the en route automation processors.

NAS to NAS

Medium speed circuits are used between adjacent ARTCCs and between ARTCCs and TRACONs for the exchange of data between computers. These circuits operate at 2400 bits per second, full duplex, and utilize the EBCDIC code of the en route automation computers.

Radar

Beacon and search surveillance data are transmitted from the remote radar sites to the ARTCC NAS 9020 computers via 2400 bit per second data channels. Beacon and surveillance radar display data are transmitted to the TRACONs and Tower "BRITE" displays via video bandwidth channels in Radar Microwave Links (RML), or coaxial cables.

9.1.2.2 NADIN

The National Airspace Data Interchange Network (NADIN) will provide data communications service to all users. Thus, it will provide the capability for message exchange between users who are presently terminated on separate networks. Users such as the FSSs and the ARTCCs, which presently have several terminals because they require access to several different networks, will be able to consolidate their operations, assigning terminals for operator convenience rather than network compatibility. The NADIN will provide code, speed, and format conversion necessary to make the unlike terminal equipments compatible. Introduction of the NADIN will provide the following improvements for the data communications users:

1. Unlike the present system which consists of a number of independent networks, NADIN will allow any user to communicate with any other user.

2. The number of terminals at some locations can be reduced.

3. By providing automatic code, speed and format conversion, traffic may be exchanged among existing terminals which are now incompatible.

4. The number of terminals on a multipoint circuit will be reduced, thereby reducing the waiting time to use the circuit.

5. By concentration, the long haul circuits will be used much more efficiently, thereby reducing the system operating costs.

6. Use of error detection and correction techniques on trunks will eliminate most transmission errors.

7. The system will maintain a record of all traffic handled. This may be used to trace messages, to analyze traffic load patterns, and provide a basis for identifying requirements for future growth.

8. The system will maintain a copy of all messages in classes that might be required for future retrieval.

9. The system will provide the means for substituting faster or more sophisticated terminals as the need for such terminals develops.

10. NADIN will monitor each terminal and for some terminal types will detect failures and initiate corrective action before the users notice that the terminal has failed.

NADIN Network

NADIN will operate in a network as illustrated in Figure 9-13. The network will include two message switching centers: one located at Atlanta, Georgia, the other at Salt Lake City, Utah, and 23 concentrators, one located with each ARTCC, including Anchorage, Honolulu and San Juan. The message switches will accept messages from originating stations, store them and transmit them to destination stations in sequence by age and priority. The concentrators will provide code and speed compatibility required for the variety of terminal devices and will concentrate all user traffic to efficiently use trunk facilities to the message switch. The functional relationship between the concentrators and message switches is shown in Figure 9-14.

NADIN Program Plan

The NADIN implementation has been divided into three phases, referred to as levels (NADIN I, NADIN II and NADIN III). In each level certain classes of traffic will be transferred into the NADIN network. In general, these categories of traffic, and the terminals of origination and termination are identified by the network which presently handles them. Where new categories of traffic are to be absorbed by NADIN, they are identified by indicating the destinations served. The NADIN levels and the categories of traffic for each are indicated in Table 9-9.

Both NADIN I and NADIN II will be implemented during the Near Term period. Data communications as of the end of the Near Term period will be as shown in Figure 9-15. It should be noted that during this period the Model 1 FSAS program will be implemented. Under this program, data communications to/from the Automated Flight Service Stations (AFSSs) will be routed

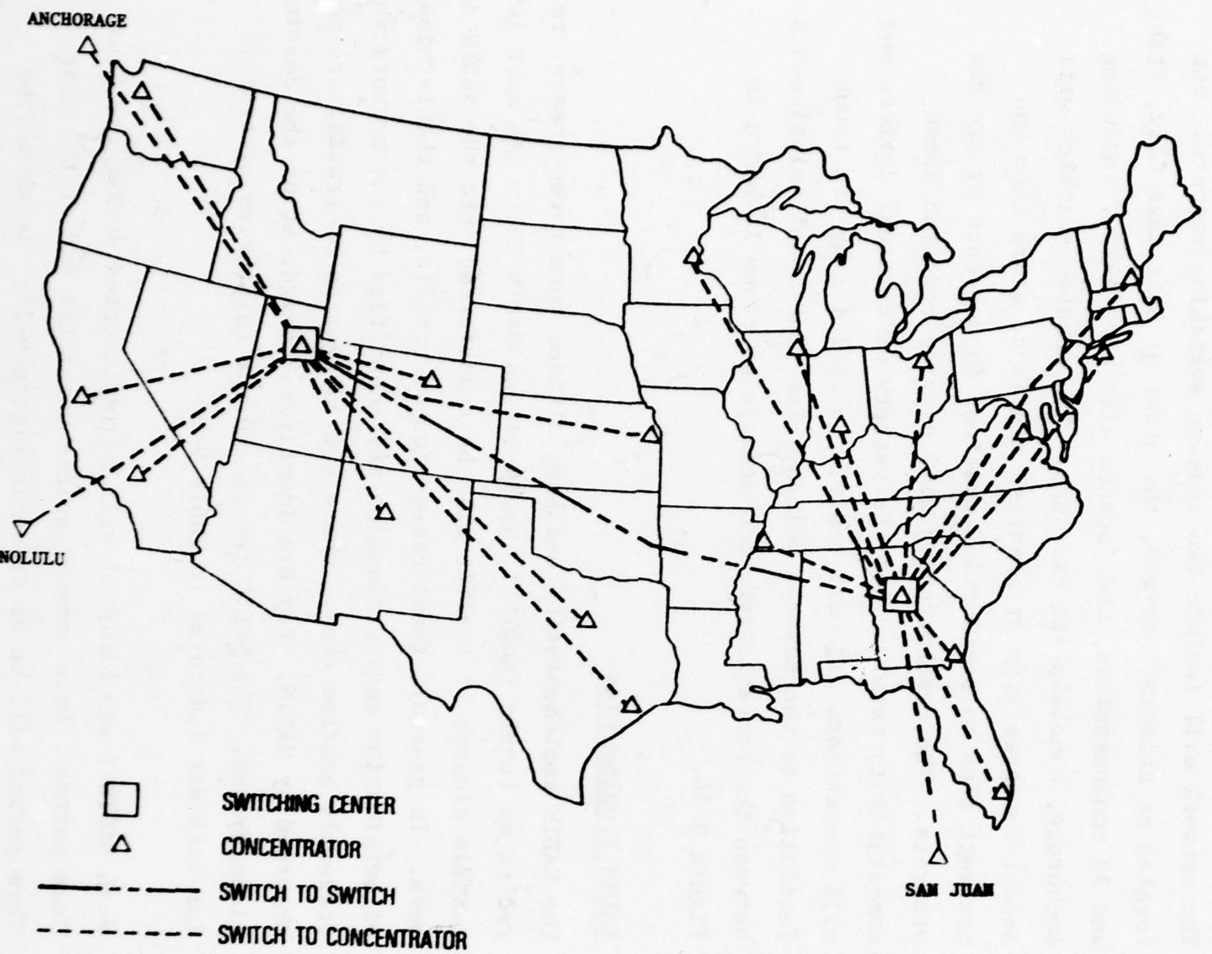


FIGURE 9-13
NADIN NETWORK

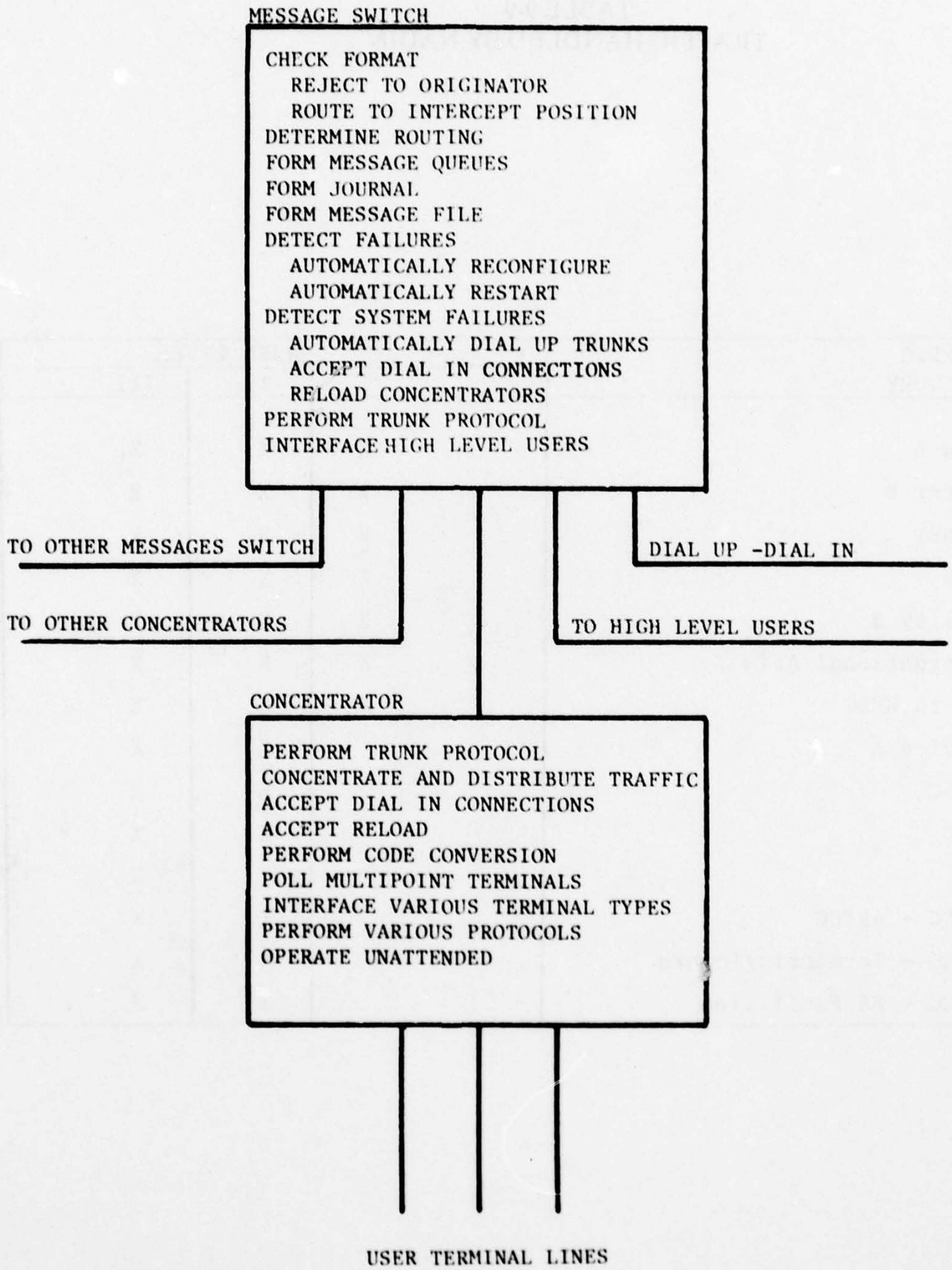
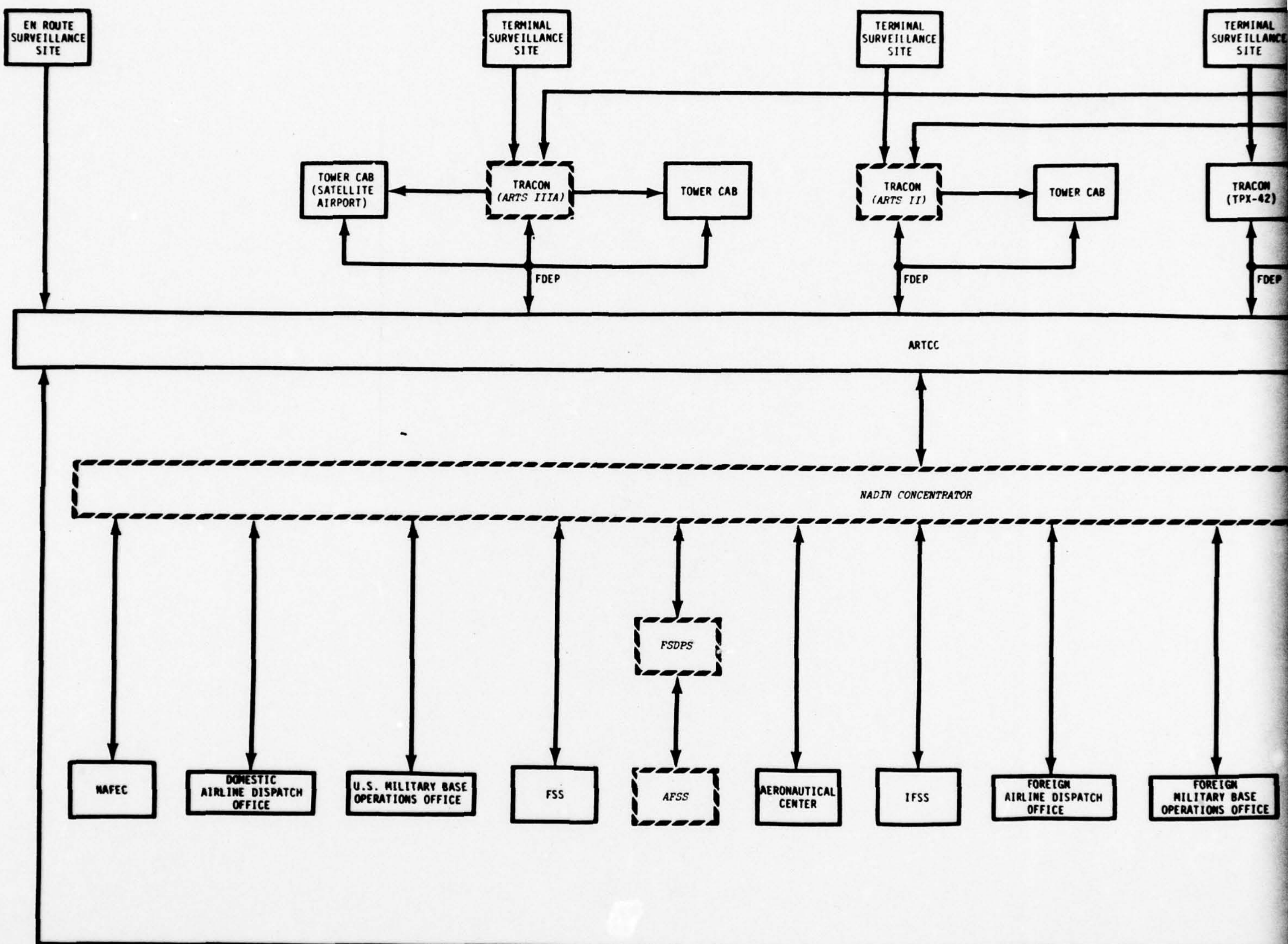


FIGURE 9-14
NADIN SUBSYSTEM FUNCTIONS

TABLE 9-9
TRAFFIC HANDLED BY NADIN

TRAFFIC CATEGORY	NADIN LEVEL I	II	III
Area B	X	X	X
Center B	X	X	X
NASNET	X	X	X
AFTN	X	X	X
Utility B	X	X	X
International AFTN	X	X	X
NWS to WMSC	X	X	X
Service A		X	X
ATCSCC		X	X
CFJC		X	X
AWP			X
ARTCC - ARTCC		X	X
ARTCC - Terminals/Towers		X	X
ARTCC - FS Facilities		X	X



__NOTE__: Changes from the Current system to the Near Term are indicated in *italics*.

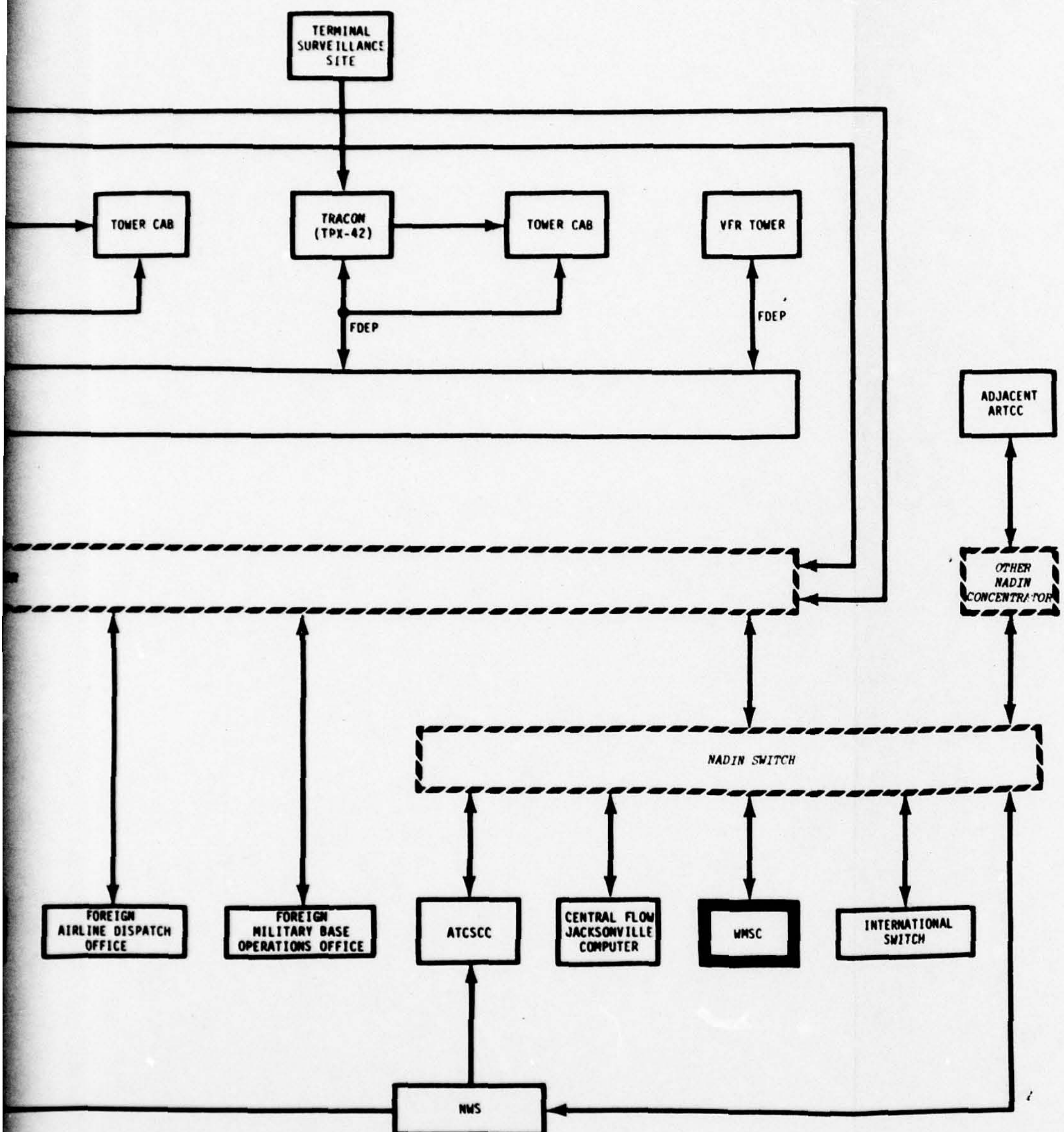


FIGURE 9-15
NEAR TERM DATA COMMUNICATIONS

2

through FSDPS. Also during this period surveillance information will be transmitted in digital form through conventional voice bandwidth circuits, rather than video form as at present which requires coaxial or microwave facilities.

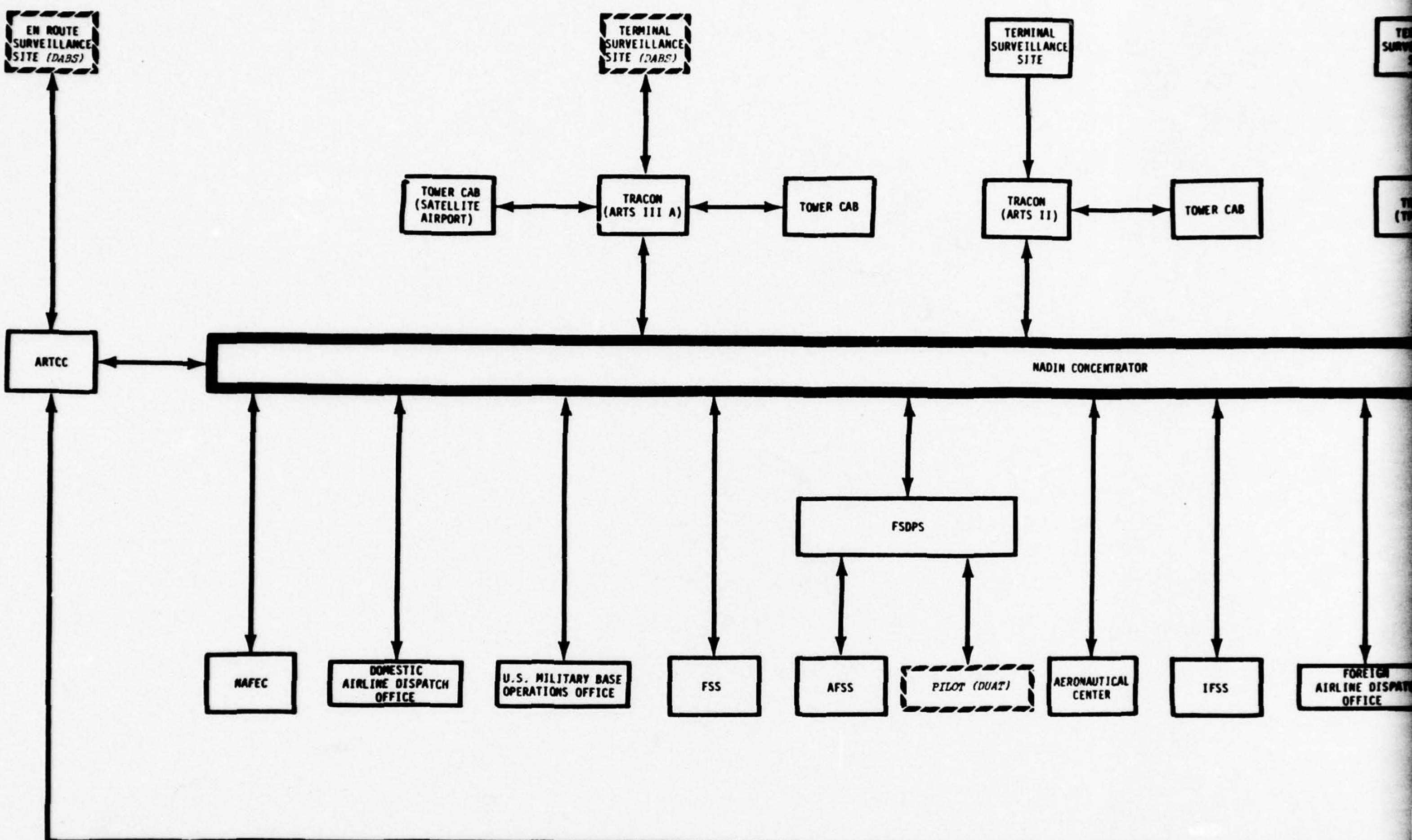
Data Communications in the Far Term will be as shown in Figure 9-16. During this period Model 2 FSAS will provide further automation through incorporation of the Aviation Weather Processor (AWP), introduction of some Direct Access User Terminals (DUAT), further refinement of the FSDPS, and a gradual phase out of the non-automated FSSs.

9.1.3 Tentative Data Communications Implementation Schedule

Current planning is to implement NADIN following the schedule shown in Figure 9-17.

9.1.4 Data Communications Interface Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in the various options for implementing the output of the E&D program to be kept open until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in the en route facility, and how they would interact with other facilities.



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

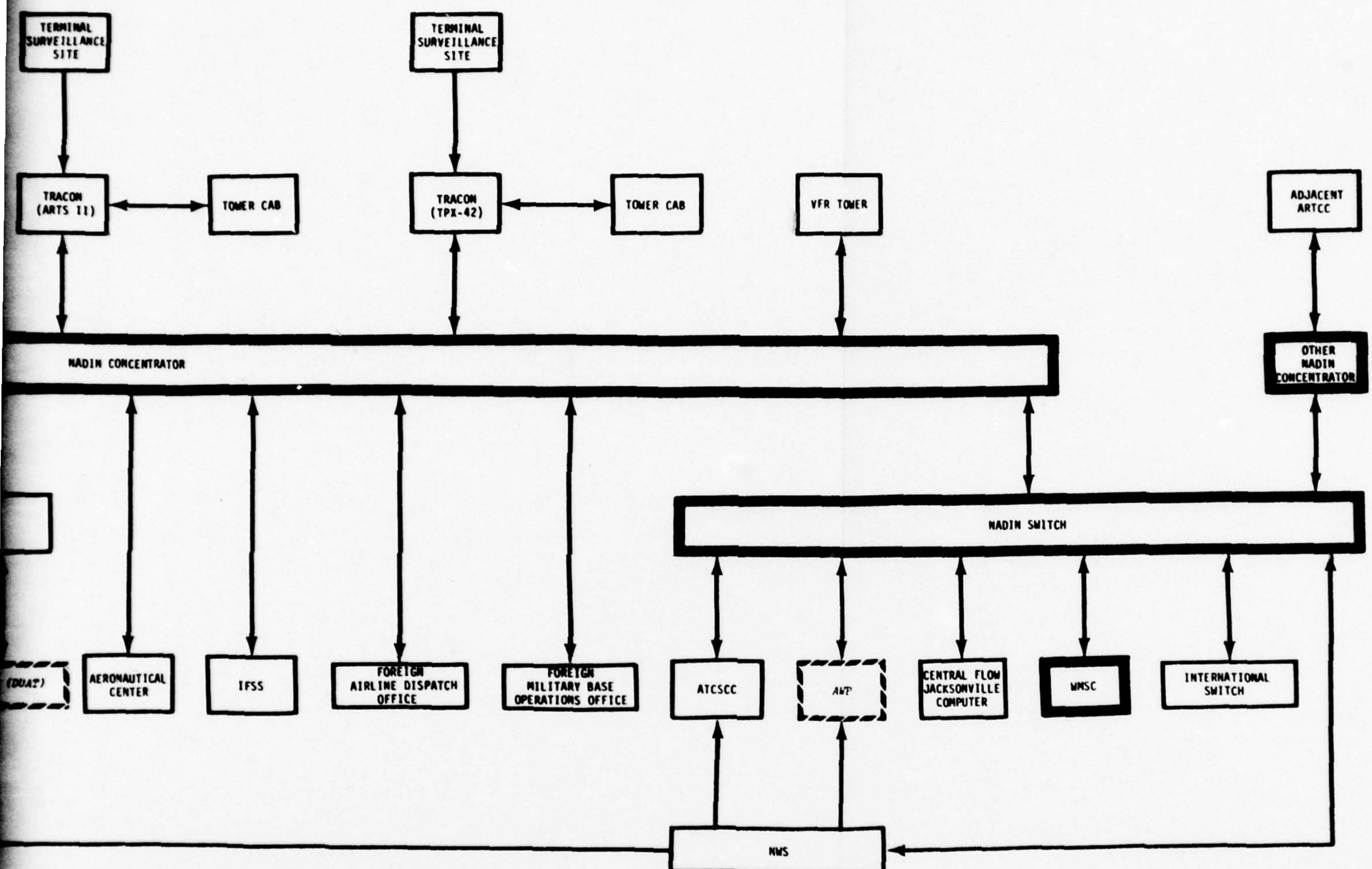


FIGURE 9-16
FAR TERM DATA COMMUNICATIONS

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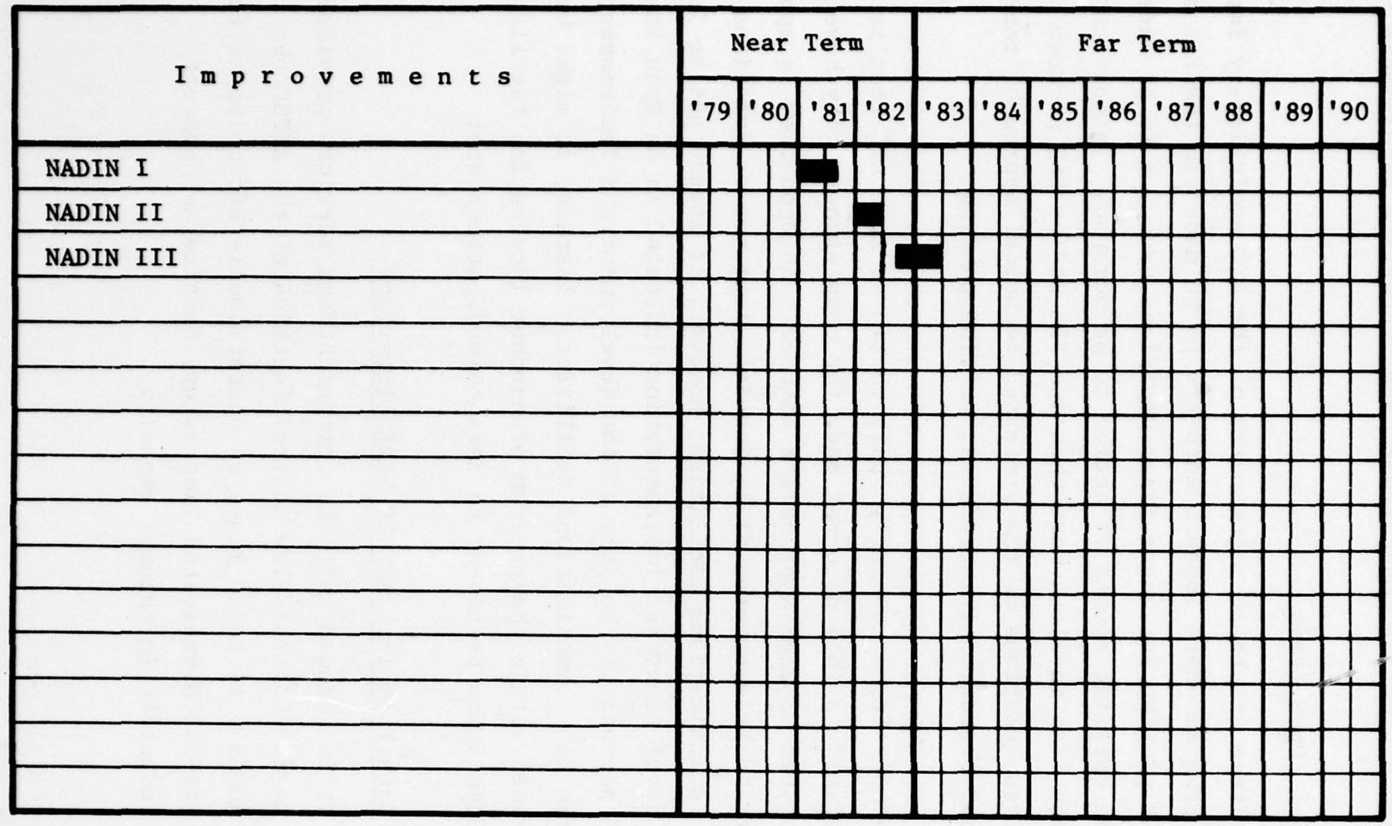

Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

FIGURE 9-17
NADIN IMPLEMENTATION SCHEDULE

This section identifies assumptions and areas of uncertainty by what are called "Open Items" and "Interface Adjustments."

9.1.4.1 Open Items

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, an Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the data communications facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for communications facilities. Instead, it might be contained within the program of another interfacing facility. The Open Items pertinent to data communications are:

Open Item 13: ATCSCC-NADIN Interface

It is assumed that the communications services provided to the Central Flow Control function of the ATCSCC by NADIN will be at least as operationally effective as the pre-NADIN dedicated line setup, despite an apparent reduction in channel capacity.

Open Item 16: Flight Service Automation and NADIN Schedule Compatibility

1. Implementation of NADIN will begin in early 1981 and will not be operational in time to initially provide the expanded data communications capability required for the Model 1 FSAS improvements that will also be implemented starting in early 1981. Interim data communication capability for FSAS Model 1 will be provided by the Area B and Service A networks.

2. Implementation of NADIN II will begin in early 1982 and will be operational in time to provide the additional expansion of the data communication capability that is needed to support Model 2 FSAS improvements that will begin implementation in early 1983.

3. Implementation of NADIN III will begin in late 1982 and will be operational in time to provide the added data communication features needed to support the FSAS Aviation Weather Processor that will become operational in early 1983.

9.1.4.2 Interface Adjustments

This section identifies some fairly specific smaller scale interface uncertainties. These uncertainties generally involve minor design modifications in one or more programs that are not considered as significant as the previously cited Open Items. The Interface Adjustments pertinent to Data Communications are:

Interface Adjustment B9-1 -- Data Flow Between En Route Computers via NADIN

Interchange of data between en route computers in the Near Term and Far Term can be via NADIN, rather than via

dedicated channels as in the Current system. An interface will exist between each ARTCC and a NADIN concentrator to serve other purposes. The issue here is whether NADIN can handle all the data in a timely manner. Time critical messages, such as radar handoff messages, can be given priority, but there may still be an unacceptable delay. A study should be made to determine if NADIN will be suitable for use in switching data between en route computers. In the meantime, an assumption is made that NADIN will serve that function.

Interface Adjustment B9-2 -- Data Link Rate to ARTCC

The data rate on the data link from a DABS site to an ARTCC in the Far Term is not firmly established. An assumption has been made that a 4800 bps channel will handle the data. The data rate requirement should be verified.

Interface Adjustment B9-3 -- Redundant Data Link Channel to ARTCC

It is not clear whether a redundant channel will be provided for data link to an ARTCC. An assumption has been made that a redundant channel will be provided, but this needs to be verified.

Interface Adjustment B9-4 -- Redundant Channel from Radar Site to ARTS III TRACON/Tower

A redundant channel could be provided from each radar site to the TRACON/Tower. However, an assumption is made that no redundant channel is provided. The requirement for a redundant channel should be verified.

Interface Adjustment B9-5 -- Data Link Rate to ARTS III TRACON/Tower

The data rate on the data link from a DABS site to an ARTS III in the Far Term is not firmly established. An assumption has been made that a 2400 bps channel will handle the data, but this should be verified.

Interface Adjustment B9-6 -- Redundant Data Link Channel to ARTS III TRACON/Tower

It is not clear whether a redundant channel will be provided for data link to an ARTS III. An assumption has been made that a redundant channel will be provided, but this assumption should be verified.

Interface Adjustment B9-7 -- TRACON/Tower Interfaces with NADIN

A NADIN interface is described in the NADIN specification for only one general type of TRACON/Tower: an ARTS. NADIN is assumed to interface with ARTS II, ARTS III and the TPX-42 replacement. This assumption should be verified.

Interface Adjustment B9-8 -- NADIN Interface with TIPS

The NADIN specification does not define an interface with TIPS. When TIPS is installed, NADIN will be required to interface with it for transfer of data to both TIPS and to ARTS III. The type of interface with NADIN should be clearly defined.

Interface Adjustment B9-9 -- Center B TTY Network for Flow Control

The SCC is on the Center B TTY network for transfer of flow control information to TTY stations in the ARTCCs.

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In the Near Term and Far Term channel capacity will be available between the SCC and the NADIN switches, (on the return path of channels used to transfer data from the CFJC to the SCC) and between the NADIN switches and the ARTCCs. It is assumed that this path would be used for the flow of directives to the ARTCCs for print-out on a suitable printer, rather than continuing to depend on the Center B teletype circuits. This assumption should be verified.

Interface Adjustment B9-10 -- Replacement of AIRS

The Airport Information Retrieval System (AIRS) is assumed to be replaced in the current time frame by the CFJC. The static data base provided by AIRS will be included in CFJC, and an interface between the SCC and AIRS will not be required. This assumption should be verified.

Interface Adjustment B9-11 -- Weather Data Flow

The flow of weather data should be reevaluated. The FSAS program calls for weather observation data to enter the AWP before it goes to the WMSC in order to include it in the data base at the earliest possible time. In addition it calls for the entire output of the WMSC, which includes the weather observations, to be transmitted to the AWP. A substantial portion of the AWP workload will be the task of filtering out duplicate copies of the weather observations. Alternative flow patterns could eliminate this duplication. Traffic projections should be analyzed to determine the scope of this processing effort and the quantity of duplicate messages that will be transmitted. This analysis would provide a basis for evaluating the presently planned flow patterns.

Interface Adjustment B9-12 -- FSS Data Capacity

Considerable improvement has taken place in the definition of graphic products since the last estimate of data traffic to support the FSS automation. A revised estimate of this traffic volume should be made based on latest information.

Interface Adjustment B9-13 -- NADIN Specification

The current NADIN Specification defines NADIN Level I and it includes an appendix to define the traffic volumes for NADIN Levels II and III. However, there is no document to provide a definitive specification of the functions, characteristics and interfaces of NADIN Levels II and III. Analysis work should be performed to further define NADIN Levels II and III, and specifications should be written.

Interface Adjustment B9-14 -- Long Range Features

Certain features of long range interest should be examined for possible incorporation into NADIN so they will be available when needed. Such features include:

- Interfaces to allow remote monitoring of hardware operability.
- Interface to allow traffic load to be dynamically monitoried, to provide for automatic allocation of trunk facilities.
- Means for monitoring circuit quality so that failures can be anticipated and corrective action taken before the circuit degrades to the point of introducing errors or limiting traffic flow.

Interface Adjustment B9-15 -- Graphic Data for AWP

The NADIN program will provide full duplex trunks between the NMC and both NADIN switches and between the WMSC and both NADIN switches in order to provide the highest level of reliability for weather products flowing from the NMC to the WMSC. Connections will be provided between the AWP and its colocated NADIN switch for transferring alphanumeric weather data into the AWP and for all data distributions from the AWP. These connections could also be used for the flow of graphic data from NMC to the AWP, resulting in the saving of the cost of the dedicated connection between the NMC and the AWP.

Interface Adjustment B9-16 -- ATCSCC Concentrator

In the Current time frame, multiplexing equipment is used to provide four channels on each of two lines to support up to eight printers and/or data terminals at the ATCSCC. In the Near Term and Far Term NADIN will be used for this data flow. A concentrator will be required which is compatible with NADIN to support the input/output devices at the ATCSCC. The characteristics of such a device should be established and a specification should be prepared to support procurement of such a device. An alternative approach might be to use a near-by NADIN concentrator with separate lines from that concentrator to each input/output device.

9.2 Voice Communications

This section considers the facilities that provide the air-ground-air voice communications between FAA operated ATC facilities and aircraft operating in CONUS as well as ground-ground voice communications between FAA operated ATC facilities (and some non-FAA operated user locations such as military base operations office and airline dispatch office), and for communications between personnel within the ATC facilities. The emphasis is on those communication facilities directly related to the provision of ATC services; administrative communications such as those provided through the Federal Telephone Service (FTS) are not addressed. Some air-ground-air communications facilities provide connectivity between the aircraft and the en route and terminal air traffic controllers through whose sectors the aircraft happens to be flying. Other air-ground facilities provide connectivity between VFR aircraft and Flight Service Station (FSS) specialists who maintain radio contact with the VFR pilot for the communications of weather, NOTAM, PIREP, NAVAID status or other en route advisory information. In addition, there are continuous scheduled and unscheduled air-ground broadcasts. The ground-ground communication facilities provide connectivity among the ATC system command center, en route center, flight service facilities, terminal facilities, airline dispatch office and military base operations office. In addition, the ground voice system provides connectivity between controller specialists within a facility and their supervisory personnel. The ground system also provides pilots with access to voice-recorded information.

9.2.1 Voice Communications Improvements

An improvement currently underway and expected to be continued in the Near Term is the replacement of vacuum tube transmitters and receivers by solid state equipment in all the FAA's air-ground

systems, including NAVAIDS. In this time frame, a Remote Maintenance Monitoring System (RMMS) is also planned to be implemented in the en route Remote Communication Air Ground (RCAG) facilities.

Major Far Term improvements that are anticipated for the ARTCCs and Terminal areas (TRACONs and towers) include the Voice Switching and Control System (VSCS). Current FAA thinking envisions that this program has three basic components, some of which are better defined than others. First of these is the RCAG Tone Control replacement program. The second component is the Remote Communications Control System (RCCS) for upgrading the connectivity between the centers and terminals on the one hand and the transmitters and receivers on the other. The third component of the VSCS addresses the ground-ground voice systems at the centers and the terminal areas.

Also in this time frame, new, higher gain, ruggedized, and radomed VHF/UHF antennas are expected to be introduced. The new antennas will be implemented in all FAA communications facilities. Also, in the Far Term, an integrated air-ground and ground-ground voice communications system is expected to be implemented in low activity tower facilities. This activity is referred to as the Small Voice Switching System (SVSS).

A potential improvement is the implementation of the VSCS to provide improved air-ground and ground-ground voice communication service to flight service facilities. Furthermore, it is the intent of the FAA that all future communications systems would be conceived and developed within a framework of a conceptual plan providing for an integrated national airspace communication system. Such an integrated system would have four component subsystems:

- Data Communications Subsystem.
- Radio Communications Subsystem.
- Voice Communications Subsystem.
- Technical Control Subsystem.

9.2.1.1 En Route Improvements

A summary of the expected improvements of the communications links for the ARTCC is shown in Table 9-10 (References 9-6 and 9-10). The table briefly describes the en route air-ground (A-G) and ground-ground voice communications facilities in the current time period, and the improvements which are expected to be implemented in the Near Term and in the Far Term. The A-G link between the en route controller and the aircraft is accomplished through Remote Communications Air-Ground (RCAG) VHF/UHF transceivers, antennas, and the associated lines and signaling, monitoring, reconfiguration and trunk restoral subsystems.

Until recently, the RCAGs have exclusively used vacuum tube equipment. A modernization program is currently underway to replace those vacuum tube transceivers with solid state equipment in all of the RCAGs. This modernization will continue into the Near Term. Another improvement in the Near Term is in the area of remote maintenance monitoring. Currently, the monitoring, reconfiguration and trunk restoral functions of the air-ground link are done manually in most facilities. However, some facilities have an outdated monitoring/switching system called Line Automatic Sensing and Switching (LASS) system. This system was found too expensive for widespread use by the FAA and it is currently being removed from the facilities that it services.

TABLE 9-10
EN ROUTE FACILITIES VOICE COMMUNICATIONS
IMPROVEMENT SUMMARY

FUNCTIONS	CURRENT (1978)	NEAR TERM IMPROVEMENTS (1979-1982)	FAR TERM IMPROVEMENTS (POST-1982)
EN ROUTE AIR-GROUND FACILITIES			
• EN ROUTE CONTROLLER -- PILOT			
- TRANSCEIVERS	RCAG (V.T.)	SOLID STATE RCAGs*	NC
- LAND LINES	NONSWITCHED PT -- PT	NC	ABSORBED BY RCCS/VSCS
- ANTENNAS	UHF/VHF ANTENNAS	NC	NEW HIGHER GAIN ANTENNAS
• SIGNALING	TONE CONTROL	NC	RCAG TONE CONTROL REPLACEMENT
• MONITORING, RECONFIGURATION & TRUNK RESTORAL	LINE AUTOMATIC SENSING & SWITCHING (LASS) IN SOME FACILITIES	RCAG REMOTE MAINTENANCE MONITORING	RCCS/VSCS
• BACK UP EMERGENCY COMMUNICATIONS	AT ARSR SITES VIA RML LINKS	NC	NC
EN ROUTE GROUND-GROUND FACILITIES			
• EN ROUTE CONTROLLER — TRACON/TOWER, FSS, ATCSCC, OTHER EN ROUTE FACILITY, MILITARY BASE OPERATIONS OFFICE, AIR LINE DISPATCH OFFICE	SERVICE F (INTERPHONE)	NC	ABSORBED BY VSCS
• EN ROUTE CONTROLLER — EN ROUTE CONTROLLER (INTERNAL)	INTERCOM	NC	ABSORBED BY VSCS
• SWITCHING & SIGNALING	WECO 300	NC	VSCS
• MONITORING, RECONFIGURATION & TRUNK RESTORAL	MANUAL	NC	VSCS

NC = NO CHANGE

*APPROVED BY THE FAA FOR IMPLEMENTATION.

The monitoring function will be enhanced in the Near Term by the implementation of the Remote Maintenance Monitoring System. This system is part of an overall program for remote maintenance and monitoring of RCAGs, surveillance sites, and VORTACs with a central processor at the ARTCC. A somewhat detailed discussion of RMMS is presented in Section 2 of this report. However, for the purpose of this section, it suffices to say that the planned capabilities include automated monitoring of operational equipment, environmental conditions and alarms. They include, remote certification, record keeping and trend analysis. The RMMS functions also include remote control of the RCAGs, but this remote control would be limited to the operation of backup power equipment and will not involve main-standby transceivers selection or frequency selection. These will be part of a Far Term improvement associated with the replacement of the tone control signaling equipment at the RCAG.

The relay and vacuum tube tone control equipment that is currently operational at the RCAGs has been demonstrated to be costly to maintain due to obsolete technology. According to current planning, this equipment would be replaced by new solid state equipment possibly with digital signaling techniques. An improvement currently in the planning for the Far Term system is the Radio Communications Control System (RCCS). Although RCCS concepts are still developing, one of these concepts includes inband digital signaling to replace tone control equipment. It also includes remote monitoring and automated reconfiguration and trunk restoral. The resulting overlap between RCCS system concepts on the one hand and the RMMS and Tone Control Replacement program concepts, on the other is recognized and discussed

in the FAA's draft 06 E&D communications program plan (Reference 9-10). Attempts will be made to design the RCCS, and the RCAG tone control replacement so that there would be some level of compatibility which would minimize discarding of some equipment.

Another improvement in the Air-Ground communications link in the Far Term is the development of the next generation UHF/VHF antennas. The increased A-G channel assignment with narrower bandwidth requirements (25 KHz) and the required use of lower transmitter power (10 watts instead of 50 watts) has led to an R&D program aimed at selecting new FAA antenna standards (Reference 9-11). The new standards would incorporate higher gain and some directivity where desirable, would be ruggedized, radomed and possibly stacked in some cases.

Although RCAGs provide the main air-ground communications outlet for the ARTCCs, the FAA has had the BUEC (Back-Up Emergency Communications) system as a backup to the RCAGs. Many of the transceivers of the BUEC system are located at the en route radar sites, and the connectivity is accomplished by Radar Microwave Links (RML) and leased telephone lines.

The en route ground-ground voice communications system consists of the networks that connect the en route center to other FAA facilities, the internal ARTCC interphone communication system connecting controller to controller and to supervisor, the switching/signaling systems, and systems conducting monitoring, reconfiguration and trunk restoral functions. The set of dedicated circuits/networks that currently connects the en route center to other FAA facilities is generally referred to as the Service F interphone. There are two levels of service associated with the

interphone network, one of which is extensive and the other limited. The extensive service makes possible the connectivity between any FAA facility and any other FAA facility in the Conterminous U.S. The limited service applies to the connectivity between an ARTCC and military Base Operations Office or Airline Dispatch office. Through Service F, these facilities are connected to their host or neighboring FAA facilities.

The ground-ground voice switching and signaling functions currently performed at en route centers are conducted by the WECO 300 switch and other associated signaling subsystems. This is electromechanical type equipment leased from AT&T. The monitoring, reconfiguration and trunk restoral functions are currently conducted manually from patch panels by cross-connections. It is expected that there would be no change to these systems in the Near Term. The Far Term improvements are not yet defined, but is expected that these systems or their replacements would be absorbed by the Voice Switching and Control System (VSCS). In fact, as has been mentioned earlier, it is the intent of the FAA to have an integrated radio and ground voice communications system design. Under such a concept, the RCCS, and a ground voice switching system would both be components of VSCS.

9.2.1.2 TRACON/Tower Improvements

A summary of the potential improvements in the communications links for the TRACON/Tower facilities is shown in Table 9-11 (References 9-6 and 9-10). The table briefly describes the terminal system air-ground and ground-ground communications facilities in the current time period, and the improvements which are expected to be implemented in the Near and the Far Terms. The A-G link between the TRACON/tower controller and the aircraft is accomplished either through local transceivers or Remote

TABLE 9-11
TRACON/TOWER FACILITIES VOICE COMMUNICATIONS
IMPROVEMENTS SUMMARY

FUNCTIONS	CURRENT (1978)	NEAR TERM IMPROVEMENTS (1979-1982)	FAR TERM IMPROVEMENTS (POST-1982)
TRACON/TOWER AIR-GROUND FACILITIES			
• TRACON/TOWER CONTROLLER -- PILOT			
- TRANSCEIVERS	V.T. EQUIPMENT IN LOCAL TRANSCEIVERS, RTR	SOLID STATE TRANSCEIVERS*	NC
- LAND LINES	NONSWITCHED PT -- PT	NC	LINES ABSORBED INTO RCCS/VSCS
- ANTENNAS	UHF/VHF ANTENNAS	NC	NEW HIGHER GAIN ANTENNAS
• SIGNALING	TONE CONTROL	NC	RCCS/VSCS (IN BAND DIGITAL SIGNALING) SVSS FOR SMALL TOWERS
• MONITORING, RECONFIGURATION & TRUNK RESTORAL	MANUAL	NC	RCCS/VSCS (TECHNICAL CONTROL ELEMENTS IMBEDDED) SVSS FOR SMALL TOWERS
TRACON/TOWER GROUND-GROUND FACILITIES			
• TRACON/TOWER CONTROLLER -- ARTCC, ATCSCC, ASSOCIATED TOWER/TRACON MILITARY BASE OPERATIONS OFFICE, AIRLINE DISPATCH OFFICE	SERVICE F	NC	ABSORBED BY VSCS
• SWITCHING & SIGNALING	WECO 301 OR SMALLER KEYING SYSTEM	NC	SVSS FOR SMALL TOWERS, VSCS FOR OTHERS.
• MONITORING, RECONFIGURATION & TRUNK RESTORAL	MANUAL	NC	VSCS

NC = NO CHANGE INCLUDED IN CURRENT PLANS

*APPROVED BY THE FAA FOR IMPLEMENTATION.

Transmitter/Receivers (RTR), the associated UHF/VHF antennas and land lines and the signaling, monitoring, reconfiguration and trunk restoral subsystems.

Until recently, the TRACON/Tower A/G facilities have exclusively used vacuum tube equipment. A modernization program is currently underway to replace vacuum tube transceivers with solid state equipment for all TRACON/Tower facilities. This program would continue into the near future. The land lines connecting the TRACON/Tower controller to the transceivers are currently point-to-point nonswitched lines. In the Far Term, these lines would be absorbed by the RCCS where they are expected to be utilized more efficiently. New UHF/VHF antennas (Reference 9-11) that are ruggedized, stacked and radomed are expected to be deployed in the Far Term. These antennas will be directional and have higher gain. The signaling associated with switching from main to standby is currently done by means of dc control equipment which is expected to be replaced in the Far Term by inband digital signaling via RCCS. Monitoring, reconfiguration, and trunk restoral are currently done manually and are expected to be performed by RCCS in the Far Term.

The TRACON/Tower ground-ground voice communications with other facilities are currently conducted via Service F. The voice switching and signaling is currently done by the WECO 301 and associated signaling equipment at higher activity facilities or by smaller keying systems at lower level facilities. Like the WECO 300, the WECO 301 systems are older electromechanical type equipment. The monitoring, reconfiguration and trunk restoral functions are currently done manually via patch panels or cross-connections. No changes in these ground-ground voice communications systems are planned for the Near Term. However, in the

Far Term, it is expected that the Voice Switching and Control System (VSCS) would be implemented. In large terminal areas, the VSCS addresses replacement of the voice switching system (WECO 301) and the monitoring, reconfiguration and trunk restoral. The Service F interphone would be absorbed into the VSCS. The current thinking is that the VSCS would be an integrated radio and ground voice system. With this concept, the RCCS would be a component of VSCS and it would be designed so that it would be compatible with the other elements of the integrated system.

A Far Term improvement expected for low level towers is the Small Voice Switching System (SVSS). This is an integrated radio and ground voice system which provides the signaling, switching, monitoring, reconfiguration and trunk restoral for both the radio and the ground-ground voice capability (Reference 9-12). Since some of the local radios servicing small towers are shared by FSS facilities, the SVSS would provide the proper interfaces with those facilities. Proper interface for ground-ground voice communications would also be provided with the Service F network.

9.2.1.3 FSS Improvements

A summary of the expected improvements in the voice communications links for the flight service facilities is shown in Table 9-12 (References 9-6 and 9-10). The table briefly describes the FSS A-G and ground-ground communications facilities in the current time period and the improvements which are expected to be implemented in the Near Term or in the Far Term. In the Near Term, some of the currently operating 292 FSS facilities, would be provided with automation aids and are referred to as Automated Flight Service Stations (AFSS). The automation data base and data processing capability would be at the Flight Service Data Processing System (FSDPS).

TABLE 9-12
FLIGHT SERVICE FACILITIES VOICE COMMUNICATIONS IMPROVEMENT SUMMARY

FUNCTIONS	CURRENT (1978) FSS:292	NEAR TERM IMPROVEMENTS (1979-1982) FS MODEL 1 FSDPS/AFSS	FAR TERM IMPROVEMENTS (POST-1982) FS MODEL 2 AND 3 FSDPS/AFSS/AWP
FSS AIR-GROUND FACILITIES			
• FSS SPECIALISTS -- PILOT			
- TRANSCEIVERS	VACUUM TUBE (V.T.) EQUIPMENT AT LOCAL RADIOS, RCO, LRCO, SFO, VOR-TRANSMIT ONLY	SOLID STATE TRANSCEIVERS*	NC
- LAND LINES	NONSWITCHED POINT TO POINT (PT -- PT)	NC	TO BE DEFINED
- ANTENNAS	UHF/VHF ANTENNAS	NC	NEW HIGHER GAIN ANTENNAS
• FSS SPECIALIST -- DIRECTION FINDER			
- RECEIVER	V.T. EQUIPMENT AT DF SITE RECEIVERS	SOLID STATE RECEIVERS	NC
- LAND LINES	NONSWITCHED PT -- PT LINES	NC	TO BE DEFINED
• FSS WEATHER BROADCAST -- PILOT CONTINUOUS (TWEB), HOURLY AND UNSCHEDULED BROADCASTS			
- TRANSMITTERS	V.T. EQUIPMENT AT VOR/NDB SITES	SOLID STATE TRANSMITTERS	NC
- LANDLINES	NONSWITCHED PT -- PT LINES	NC	TO BE DEFINED
• SIGNALING	TONE CONTROL	NC	TO BE DEFINED
• MONITORING, RECONFIGURATION & TRUNK RESTORAL	MANUAL	NC	TO BE DEFINED
FSS GROUND/GROUND FACILITIES			
• FSS SPECIALIST -- PILOT	DDD, WATS, FX, MINOR SWITCHING CAPABILITY	NC	
• FSS SPECIALIST -- ARTCC, TRACON/TOWER, MILITARY BASE OPERATIONS OFFICE, AIRLINE DISPATCH OFFICE	SERVICE F (INTERPHONE)	NC	TO BE DEFINED
• FSS SPECIALIST -- FSS SPECIALIST (INTERNAL)	INTERCOM	NC	
• PILOT ACCESS TO VOICE RECORDED INFORMATION (PATWAS, VRS)	DDD, WATS, FX TO PATWAS	NC	
• SWITCHING & SIGNALING	MINOR CAPABILITY	NC	
• MONITORING, RECONFIGURATION & TRUNK RESTORAL	MANUAL	NC	

NC = NO CHANGE INCLUDED IN CURRENT PLANS

*APPROVED BY THE FAA FOR IMPLEMENTATION.

The A/G link between the FSS specialist and the aircraft is accomplished through various UHF/VHF radio and antenna facilities some of which are transceivers, some are transmitters only and some are receivers only. Dedicated land lines are also used for connecting the FSS specialist to the radio facilities. Additionally, signaling, monitoring, reconfiguration and trunk restoral subsystems are used as part of the voice communication system.

The two-way A-G communications link between the FSS specialists and the aircraft is accomplished through local transceivers, Remote Communications Outlets (RCO), Limited Remote Communications Outlets (LRCO) and Single Frequency Outlets (SFO). These facilities are used to provide approach and departure channels for IFR aircraft and airport advisory service for all aircraft at airports with no control tower. The receiver-only facilities are Direction Finder (DF) facilities which are used for locating lost aircraft. The transmit only facilities are the VORs, and Nondirectional Beacons (NDB) both of which are used for transmitting scheduled and unscheduled broadcasts including Transcribed Weather Braodcasts (TWEB).

All of the A-G facilities have vacuum tube equipment but are currently being modernized to use solid state equipment. This modernization will largely take place in the Near Term. In the Far Term, the new UHF/VHF antennas (Reference 9-11) are expected to be deployed in the Air-Ground radio communications facilities associated with flight service stations. These antennas would be ruggedized, radomed, and stacked and would be installed only in communications facilities and not in navigation facilities (DF, VOR/NDB). The antennas are also expected to be directional and have an increased gain.

Signaling is currently done by tone control equipment. No change is expected to the signaling function either in the Near Term or in the Far Term. However, in the case of FS consolidation, the current tone equipment is expected to be replaced by inband digital signaling through RCCS. The monitoring, reconfiguration and trunk restoral functions are currently done manually and in the event of consolidation, these functions are expected to be automated with the advent of RCCS. With RCCS, the air-ground facilities would be further remoted, and the land lines connecting the radios to the FSS facilities would be absorbed into the RCCS system.

The FSS ground-ground voice communication system consists currently of the Service F interphone, the internal facility intercoms, a switching capability (such as the AIA Key System leased from the Telephone Company) and pilot access to voice recorded information. Minor switching and signaling capability is currently available at most FSSs. The monitoring, reconfiguration and trunk restoral functions are currently conducted in a manual fashion. No change is planned in the FSS ground voice communications in the Near Term. Changes that may occur in the Far Term are undefined as yet; however, a potential improvement is the introduction of the Voice Switching Control System (VSCS) which is an integrated radio and ground voice system. This system incorporates signaling, switching, monitoring and restoral functions. Improvements associated with the FSS modernization program such as PATWAS, and the voice response system are covered in Section 6 of this report.

9.2.2 Voice Communications Connectivity

Figures 9-18 and 9-19 present the connectivity of the FAA voice communication system in the Current time period,

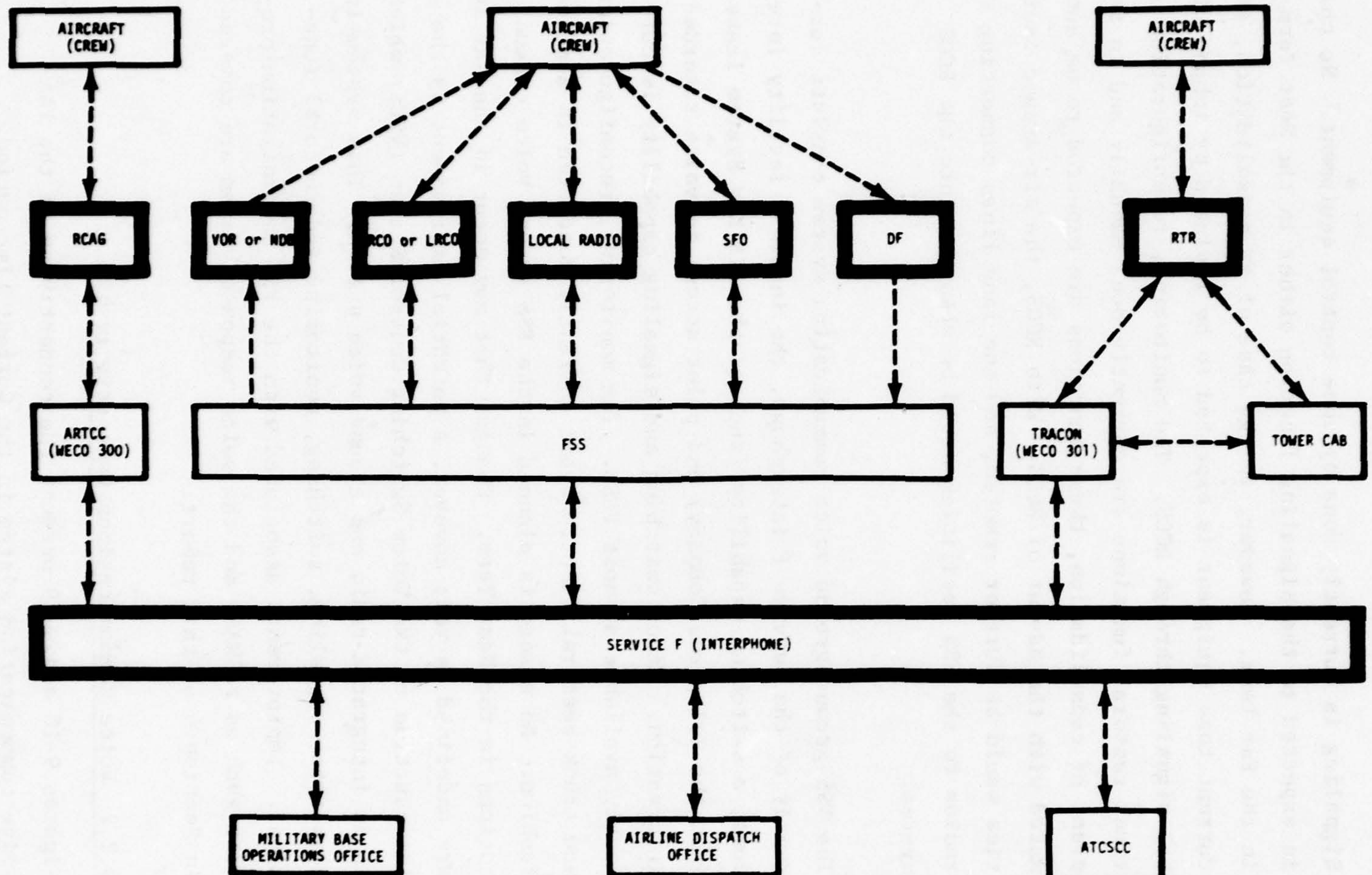
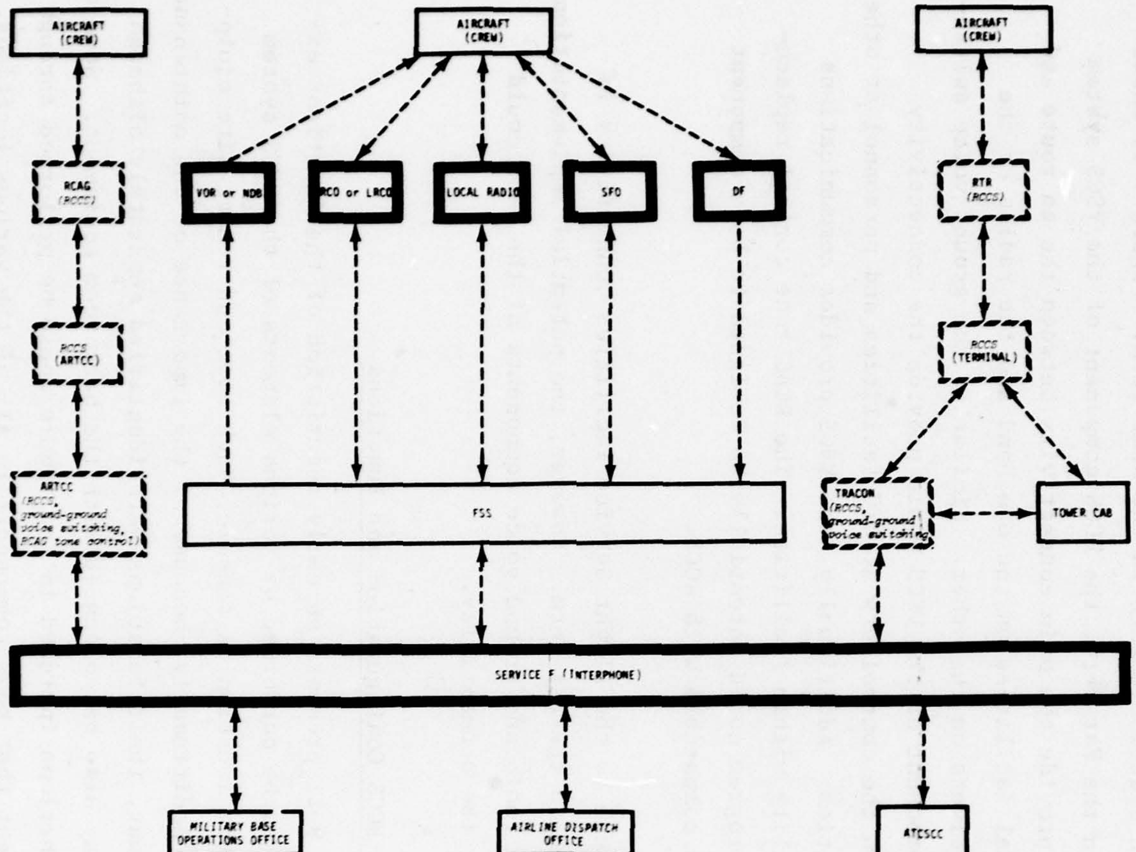


FIGURE 9-18
CURRENT AND NEAR TERM VOICE COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 9-19
FAR TERM VOICE COMMUNICATIONS CONNECTIVITY DIAGRAM

in the Near Term and in the Far Term. Figure 9-18 indicates that there will be no significant change in the connectivity between system elements in the Near Term. Figure 9-19 shows that in the Far Term, the RCCS component of the VSCS system could provide the main connectivity between the en route and terminal facilities on the one hand and the radios or the transceivers on the other. Similarly, the ground voice switching component of the VSCS would provide the connectivity between the controllers at ATC facilities and personnel at other facilities. Additionally, the VSCS provides communications capability within facilities. The RCAG tone control replacement program could potentially be designed to be a component of and compatible with RCCS.

No change to the Flight Service facilities connectivity is planned in the Far Term. However, the potential implementation of the radio and ground voice components of the VSCS could impact the connectivity.

9.2.3 RCCS Configuration and Functions

Figure 9-21 presents an early description of the functions expected to be performed by various elements of the RCCS system and their location in console, back room and remote site equipment. Additionally, because of the importance of the maintenance equipment, their functions were identified separately although they may also be colocated with the back room equipment. Some of the functions included in the figure would be performed through equipment that have components in all of the various locations. In the case of flight service consolidation, additional functions such as aera selection, muting, and DF selection would be added to the RCCS subsystem that would service the FS facilities.

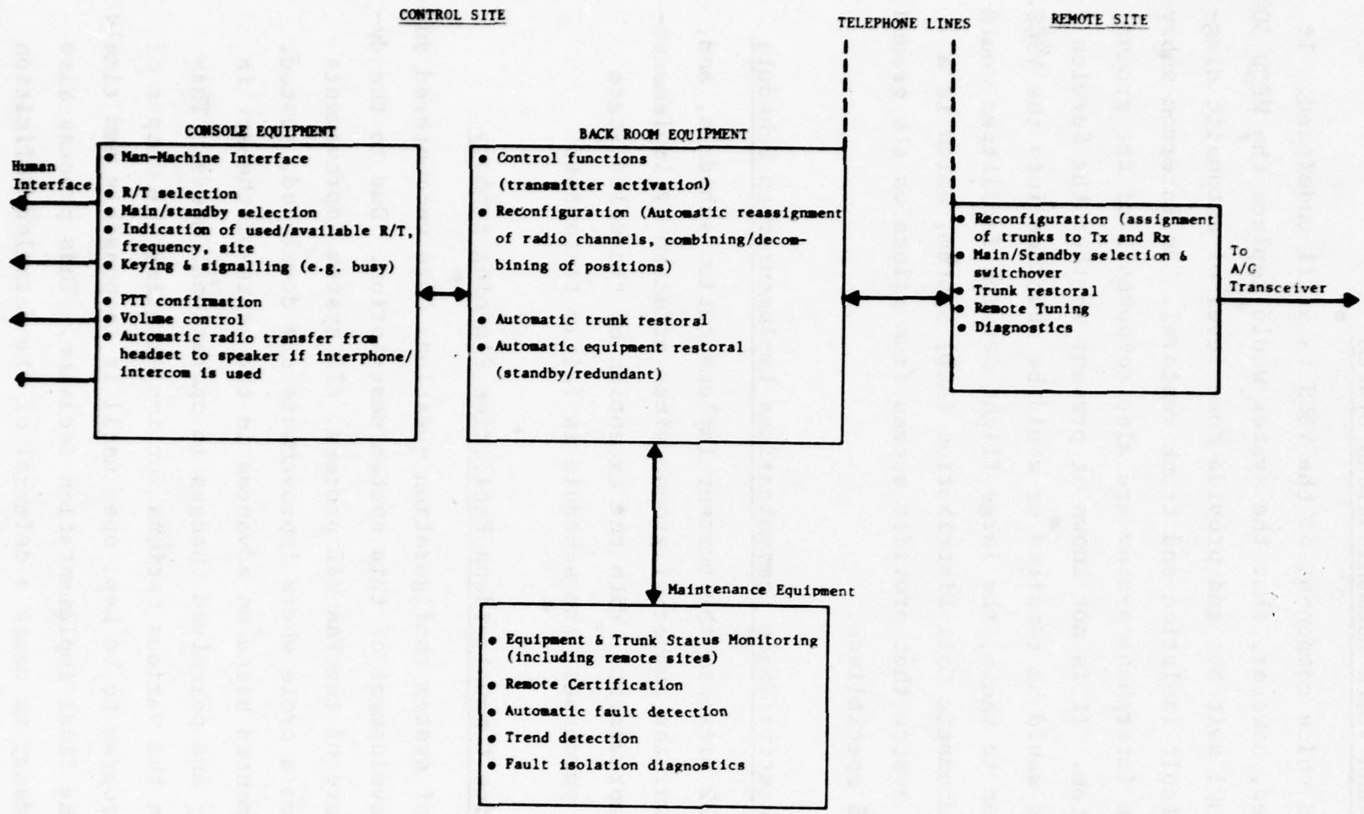


FIGURE 9-20
SIMPLIFIED RCCS CONFIGURATION AND FUNCTIONS

9.2.4 Ground Voice Communications System

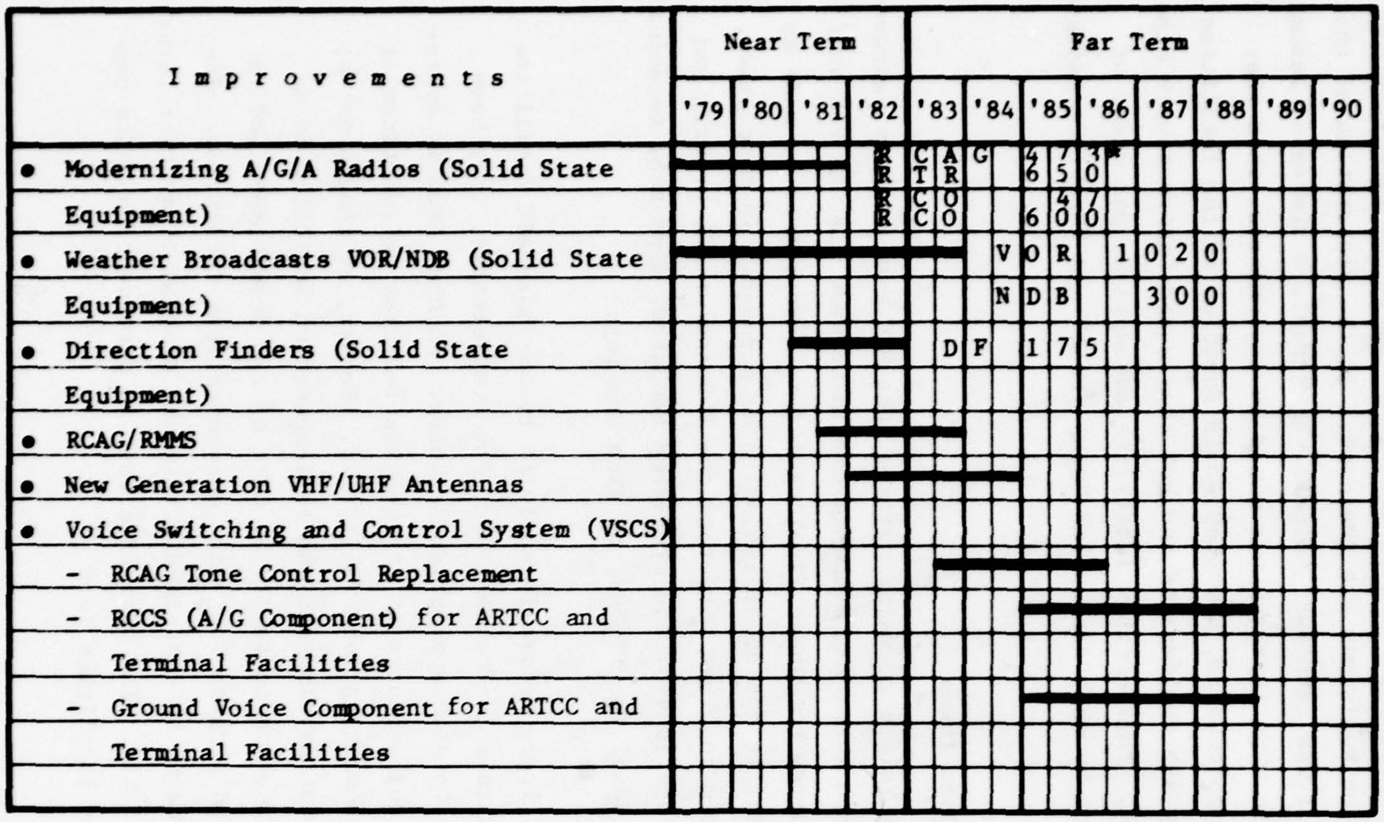
The ground voice component of the VSCS is still undefined. It is expected, however, that the system would replace the WECO 300 and WECO 301 switches and provide some level of automatic diagnostics, fault isolation and trunk restoral. An intercom subsystem and an interphone system are also components of the ground voice system. It is not known at present whether the Service F interphone would be repalced or would be absorbed into the VSCS. In addition to these, the large flight service facilities would have an Automatic Call Distribution (ACD) System, which is a switching system that provides access from pilots on the ground to the FSS specialists.

9.2.5 Tentative Voice Communications Implementation Schedule

Figure 9-22 presents the current implementation schedule, and, where known, the number of ground sites affected by implementation of improvement. With the exception of the solid state equipment purchases, the schedule is fairly tentative.

9.2.6 Voice Communications Facilities Planning Summary

A number of system configuration questions were encountered during the development of this system description. Due to the dynamic nature of the FAA E&D process, ATC system improvements evolve from a cycle where improvements are developed, tested, and implemented based on advances in the state-of-the-art in technology and perceived changes in operational needs. This results in the various options for implementing the output of the E&D program to be kept open until it is possible and timely to make the final implementation decision. This process also has a tendency to cause a deferral of the detailed definition



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first operational site will become operational and ends at the time that the last operational site will become operational.

*The current number of existing ground locations that are to be modernized.

FIGURE 9-21
VOICE COMMUNICATIONS FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE

of technical and operational interfaces until the time when implementation decisions are imminent. In the preparation of this section, it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in the facilities where they are implemented and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "Open Items" and Interface Adjustments."

9.2.6.1 Open Items

Open Items relate to major parts of the ATC evolutionary improvement program where improvements are to be made via the F&E and/or E&D program but where final decisions have yet to be made as to the specific course of action to be pursued. In most cases, an Open Item involves more than one F&E and/or E&D program and involves questions of the preferred technical approach, technical and operational interfaces, or time phasing.

These Open Items generally apply to two or more ATC facilities as defined in this document and, for completeness, they have been cited in each appropriate chapter. An Open Item is appropriate to this chapter if it involves features or functions of the voice communications facilities; however, it should not be inferred that development and implementation indicated in an Open Item would necessarily be part of the development and implementation program for voice communications facilities. Instead, it might be contained within the program of another interfacing facility. The Open Item that is pertinent to voice communications facilities is:

Open Item 15: Voice Communications Planning

1. Air-ground-air communication for the ARTCCs and major terminals will be upgraded in the post-1982 time period by implementation of the radio portion of VSCS, which would be referred to as RCCS. In the near term, RCAG tone control equipment for the ARTCCs will be replaced, possibly with a modular subsystem that would be compatible with longer term RCCS/VSCS designs. The FSS's, which are assumed to remain unconsolidated, will continue to use switching and control equipment based on existing designs. In addition, the transmitters, receivers, and antenna systems at all FAA ground sites will be replaced with modern design equipment.

2. Ground-ground communications would be modernized by the implementation of ground-ground portions of the VSCS system which would replace the WECO 300 system at ARTCCs, and the WECO 301 system at the larger terminals. The existing small key systems and call distributors at FSSs would remain in place.

3. At some smaller terminals, a Small Voice Switching System (SVSS) will be implemented, which will provide an integrated radio and ground voice communications capability.

9.2.6.2 Interface Adjustments

This section identified some fairly specific smaller scale interface uncertainties. These uncertainties generally involve minor design modifications in one or more programs that are not considered as significant as the previously cited Open Item. The Interface Adjustments pertinent to the Voice Communications Facilities chapter are:

Interface Adjustment B9-17 -- Adequacy of the Capacity of a 250 Hz Wide Slot for the RCCS Signaling

Early RCCS concepts considered reserving a portion of the information bandwidth for signaling and remote control. This portion would be a 250 Hz wide slot. It is not clear, however, whether this amount of bandwidth would be sufficient to accommodate the data required to accomplish those two functions.

Interface Adjustment B9-18 -- Adequacy of Interface of Bell System with RCCS Channels Having a 250 Hz Slot

Portions of the Bell System that would be used for transmitting the air-ground information signals may be of the digital T_1 Carrier type. It is not clear what impact the T_1 Carrier system would have on the 250 Hz slot that carries the signaling and remote control information.

Interface Adjustment B9-19 -- Monitoring/Fault Isolation Philosophy for FAA Communications Equipment

The FAA plans to continue procurring new solid state A-G equipment. It is expected that this equipment would have to interface with the monitoring/fault isolation subsystem of the RCCS. However, the A-G equipment is not currently configured for that interface.

APPENDIX A

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APPENDIX B

ABBREVIATIONS AND ACRONYMS

ABDIS	Automated Service B Data Interchange System
ACD	Airport Traffic Control Tower Consolidated Display
ACD	Automatic Call Distribution
AERA	Automated En Route Air Traffic Control
AFCD	Airport Facilities Consolidated Display
AFOS	Automation of Field Operations and Services
AFS	Airway Facilities Service
AFSS	Automated Flight Service Station
AFTN	Aeronautical Fixed Telecommunications Network
A-G	Air-Ground
A-G-A	Air to Ground to Air
AGL	Above Ground Level
AIRS	Airport Information Retrieval System
ALWOS	Automated Low-Cost Weather Observation Systems
ARO	Airline Reservation Office
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ATARS	Automated Traffic Advisory and Resolution Service
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Radar Beacon System
ATCSCC	Air Traffic Control Systems Command Center
ATIS	Automated Terminal Information System
ATS	Automated Terminal Services
AUTOVON	Automatic Voice Network
AV-AWOS	Aviation Automated Weather Observation System
AWP	Aviation Weather Processor
AWS	Air Weather Service
AWSDS	Advanced Wind Shear Detection System
AWSS	Airborne Wind Shear System
BCAS	Beacon-Based Collision Avoidance System
BRITE	Bright Radar Indicator Tower Equipment
BUEC	Back-Up Emergency Communications
CAL	Commercial Airlines
CARF	Central Altitude Reservation Function
CCC	Central Computer Complex
CCP	Contingency Command Post
CCTV	Closed Circuit Television

CD	Common Digitizer
CDC	Computer Display Channel
CFC	Central Flow Control
CFJC	Central Flow Jacksonville Computer
CMA	Control Message Automation
CONUS	Conterminous United States
CRD	Computer Readout Device
CS/T	Combined Station/Tower
CTA	Calculated Time of Arrival
CWSU	Center Weather Service Unit
DABS	Discrete Address Beacon System
DARC	Direct Access Radar Channel
DCS	Data Communications Subsystem
DDD	Direct Distance Dialing
DEDS	Data Entry and Display Subsystem
DF	Direction Finder
DME	Distance Measuring Equipment
DR&A	Data Recording and Analysis
DTE	Data Terminal Equipment
DUAT	Direct User Access Terminal
EBCDIC	Extended Binary Coded Decimal Interchange Code
EFAS	En Route Flight Advisory Service
EMSAW	En Route Minimum Safe Altitude Warning System
ETABS	Electronic Tabular Display Subsystem
FAD	Fuel Advisory Departure
FAX	Facsimile
FDAD	Full Digital ARTS Display
FDEP	Flight Data Entry and Printout
F&E	Facilities and Equipment
FP	Flight Plan
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSH	Flight Service Hub
FSS	Flight Service Station
FTS	Federal Telephone System
FWS	Flight Watch Specialist
FX	Foreign Exchange
GA	General Aviation
GPS	Global Positioning System
GOES	Geostationary Operational Environmental Satellite
HSP	High Speed Printer
HUD	Head Up Display

ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IFSS	International Flight Service Station
ILS	Instrument Landing System
IOCE	Input/Output Control Element
LASS	Line Automatic Sensing and Switching
LF	Low Frequency
LLWSAS	Low Level Wind Shear Alert System
LORAN	Long Range Navigation
LRCO	Limited Remote Communications Outlets
LSR	Limited Surveillance Radar
MIL	Military
MLF	Medium Low Frequency
MLS	Microwave Landing System
M&S	Metering and Spacing
MSAW	Minimum Safe Altitude Warning
MTBF	Mean Time Between Failure
MTBR	Mean Time Between Repair
MTD	Moving Target Detector
MTI	Moving Target Indicator
NADIN	National Airspace Data Interchange Network
NAFAX	National Facsimile Circuit
NAFEC	National Aviation Facilities Experimental Center
NAS	National Airspace System
NASCOM	National Aviation Systems Communications
NATCOM	National Communications
NAVAID	Navigational Aid
NDB	Nondirectional Beacon
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command
NOTAM	Notice to Airmen
NMC	National Meteorological Center
NWS	National Weather Service
OAG	Official Airline Guide
ORD	Operational Readiness Demonstration
OTC	Over the Counter
PATWAS	Pilot Automatic Telephone Weather Answering Service
PDME	Precision DME
PIREP	Pilot Weather Report
PVD	Plan View Display
RCAG	Remote Communications Air-Ground
RCO	Remote Communications Outlet

RCCS	Radio Communications and Control System
RCS	Radio Communications Subsystem
RDF	Radio Direction Finder
RML	Radar Microwave Link
RMMS	Remote Maintenance Monitor System
RNAV	Area Navigation
R/T	Receiver/Transmitter
RTR	Remote Transmitter/Receiver
RVR	Runway Visual Range
Rx	Receiver
SAC	Strategic Air Command
SAM	System Acquisition Management
SAMOS	Semi-Automated Meteorological Observation System
SCC	(ATC) System Command Center
SFO	Single Frequency Outlet
SFSS	Satellite Field Service Station
SMMC	System Maintenance Monitoring Console
SRAP	Sensor Receiver and Processor
SRG	Systems Requirements Group
STC	Sensitivity Time Control
SWL	Severe Weather Labs
SVSS	Small Voice Switching System
TAC	Tactical Air Command
TACAN	Tactical Air Navigation
TAGS	Tower Automated Ground Surveillance System
TCDD	Tower Cab Digital Display
TCS	Technical Control Subsystem
TDP	Technical Data Package
TIPS	Terminal Information Processing System
TSARC	Transportation Systems Acquisition Review Council
TRACAB	Terminal Radar Approach Control, Tower Cab
TRACON	Terminal Radar Approach Control, IFR Room
TRSB	Time Reference Scanning Beam
TTY	Teletypewriter
TWEB	Transcribed Weather Broadcast
Tx	Transmitter
VAS	Vortex Advisory System
VASI	Visual Approach Slope Indicator
VCS	Voice Communications Subsystem
VFR	Visual Flight Rules
VICON	Visual Confirmation of Voice Takeoff Clearance
VLF	Very Low Frequency
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnirange Station
VORTAC	Colocated VOR and TACAN

VRS	Voice Response System
VSCS	Voice Switching Control System
V.T.	Vacuum Tube
WAVE	Wind and Altimeter Voice Equipment
WBRR	Weather Bureau Remote Radar Recorder
WECO	Western Electric Company
WFMU	Weather and Fixed Map Unit
WMSC	Weather Message Switching Center
WSFO	Weather Service Forecast Office
WSR	Weather Service Radar
WVAS	Wake Vortex Avoidance System
Wx	Weather